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SITE-SPECIFIC TECHNICAL REPORT FOR BIOSLURPER TESTING AT SITES UST 70/72 AND SS010, ROBINS AFB, GEORGIA

DRAFT

PREPARED FOR:

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AND

CEOUW
ROBINS AFB, GEORGIA

28 NOVEMBER 1995

AQM01-03-0561

DRAFT

SITE-SPECIFIC TECHNICAL REPORT (A003)

for

BIOSLURPER TESTING AT SITES UST 70/72 AND SS010, ROBINS AFB, GEORGIA

by

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November 28, 1995

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This report summarizes the field activities conducted at two sites at Robins AFB, Georgia, for a short-term field pilot test to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery techniques to remove light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Robins AFB is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper Initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe, and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The tests at Robins AFB are two of at least 35 similar field tests to be conducted at various locations throughout the United States and its possessions.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Robins AFB were skimmer pumping, bioslurping, and drawdown pumping.

Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing, soil sampling, soil gas permeability testing, and in situ respiration testing.

After the site characterization activities, the pilot tests for the skimmer pumping, bioslurping, and drawdown pumping were conducted. The bioslurper system was installed in existing monitoring wells at both sites, Site Underground Storage Tank (UST) 70/72 and Site SS010. The pilot test sequence was as follows: 1 to 2 days in the skimmer configuration, 3 to 4 days in the bioslurper configuration, an additional day in the skimmer configuration (not conducted at Site SS010 due to

poor free product recovery), and 1 day in the drawdown configuration. Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volumes of LNAPL recovered and groundwater extracted were quantified over time.

Site UST 70/72 Results

Skimmer pumping was not as effective as bioslurping at recovering LNAPL from at Site UST 70/72. Free-product recovery rates remained relatively low during skimmer pumping, at an average recovery rate of 11 gallons/day during the initial skimmer pump test and decreasing to 5.0 gallons/day by the end of the second skimmer pump test. In contrast, free-product recovery rates during the bioslurper pump test remained relatively stable after the first day of operation at approximately 40 gallons/day. Drawdown pumping resulted in only slightly higher recovery than skimmer pumping and much less than bioslurping, with an average recovery rate of 12 gallons/day.

Groundwater recovery rates during the bioslurper pump test were high in comparison to rates during the skimmer or drawdown pump tests. On average, groundwater was extracted at rates of ~~5,400~~ 1400 gallons/day during bioslurping, compared to ~~1,400~~ 850 and ~~1,900~~ 2100 gallons/day during skimming and drawdown pumping, respectively.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Monitoring points at depths of 3.0 and 5.0 ft were not oxygen-limited. Oxygen concentrations increased slightly at monitoring points R1-MPA-7.0′ and R1-MPB-7.0′, but not at all at R1-MPC-7.0′. These results correlate with radius of influence results from the soil gas permeability test, where a radius of influence of approximately 57 ft was calculated. Given the low permeability of the soil, it is unlikely that soils would be oxygenated fully during the short time period of the soil gas permeability test. However, over time, it is likely that soils within the radius of influence of the bioslurper well will become oxygenated.

Implementation of bioslurping at the Robins AFB test site probably would facilitate enhanced recovery of LNAPL from the water table and simultaneous in situ biodegradation of hydrocarbons in the vadose zone via bioventing. An extended bioslurper test is planned for this site. The bioslurper system will be configured to tie into the bioslurper test well and into existing wells on site.

Site SS010 Results

Free-product recovery was poor at Site SS010 during all pump tests. The maximum recovery rate was achieved during the bioslurper pump test; however, the average recovery rate was 3.2 gallons/day compared to an average groundwater extraction rate of 1,500 gallons/day. Free-product recovery may be limited due to the site hydrogeology or the condition that only small quantities of free product may be present.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Oxygen concentrations increased slightly at all monitoring points where a soil gas sample could be collected. As at Site UST 70/72, given the low permeability of the soil, a time period longer than the length of this test may be necessary to fully oxygenate the soils. However, based on these results, it is likely that the soils will become oxygenated over time.

Implementation of bioslurping at Site SS010 does not appear to be a feasible option for free-product recovery due to the low recovery rate versus the high groundwater extraction rate. Given that free-product recovery was poor during all pump tests, the quantity of free product present may be low. Therefore, intrinsic bioremediation may be a more appropriate option for this site.

DRAFT SITE-SPECIFIC TECHNICAL REPORT (A003)

for

BIOSLURPER TESTING AT
SITES UST 70/72 AND SS010, ROBINS AFB, GEORGIA

November 28, 1995

1.0 INTRODUCTION

This report describes activities performed and data collected during two field tests at Robins Air Force Base (AFB), Georgia, to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery technologies for removal of light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Robins AFB is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper Initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

1.1 Objectives

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The tests at Robins AFB are two of at least 35 similar field tests to be conducted at various locations throughout the United States and its possessions. Aspects of the testing program that apply to all sites are described in the *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). Test provisions specific to activities at Robins AFB are described in the Site-Specific Test Plan provided in Appendix A of this report.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping

technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Robins AFB were skimmer pumping, bioslurping, and drawdown pumping. The specific test objectives, methods, and results for the Robins AFB test program are discussed in the following sections.

1.2 Testing Approach

Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing to evaluate the mobility of LNAPL, soil sampling to determine physical/chemical site characteristics, soil gas permeability testing to determine the radius of influence, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the pilot tests for skimmer pumping, bioslurping, and drawdown pumping were conducted. The LNAPL recovery testing was conducted in the following sequence at both sites: 1 to 2 days in the skimmer configuration, 3 to 4 days in the bioslurper configuration, 1 additional day in the skimmer configuration (not conducted at Site SS010 due to poor free-product recovery), and 1 day in the drawdown configuration. Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

2.0 SITE UST 70/72

2.1 Site Description

Site Underground Storage Tank (UST) 70/72 is located in the 19th and 912th Air Refueling Wing located in the northeastern quadrant of Robins AFB. USTs 70 and 72 were installed in 1958 and have been used continuously since that time. The two tanks originally were used for JP-4 jet fuel storage, but were converted over to JP-8 jet fuel storage in June 1994. According to the Fuels

Maintenance Branch Staff at Robins AFB, large nondocumented releases of JP-4 jet fuel have occurred at UST 70 several times. Site characterization activities have shown soil and groundwater contamination.

Figure 1 illustrates the locations of monitoring wells at Site UST 70/72. Free product has been detected regularly in monitoring wells EA-1 and EA-2.

2.2 Bioslurper Short-Term Pilot Test Methods

This section documents the initial conditions at the test site and describes the test equipment and methods used for the short-term pilot test at Robins AFB.

2.2.1 Initial LNAPL/Groundwater Measurements and Baildown Testing

Monitoring well EA-2 was evaluated for use in the bioslurper pilot testing. Initial depths to LNAPL and to groundwater were measured using an oil/water interface probe (ORS Model #1068013). LNAPL was removed from the well with a Teflon™ bailer until the LNAPL thickness could no longer be reduced. The rate of increase in the thickness of the floating LNAPL layer was monitored for approximately 22 hours using the oil/water interface probe.

An LNAPL sample was collected after completing the baildown test and was labeled R1-Fuel-1. The sample was sent to Alpha Analytical, Inc., Sparks, Nevada for analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX) and for boiling point fractionation.

2.2.2 Well Construction Details

Existing monitoring well EA-2 was selected for use in the bioslurper pilot testing. The well is constructed of 4-inch-diameter, schedule 40 polyvinyl chloride (PVC) with a total depth of 14 ft and 10 ft of screen. A schematic diagram illustrating well construction details is provided in Figure 2.

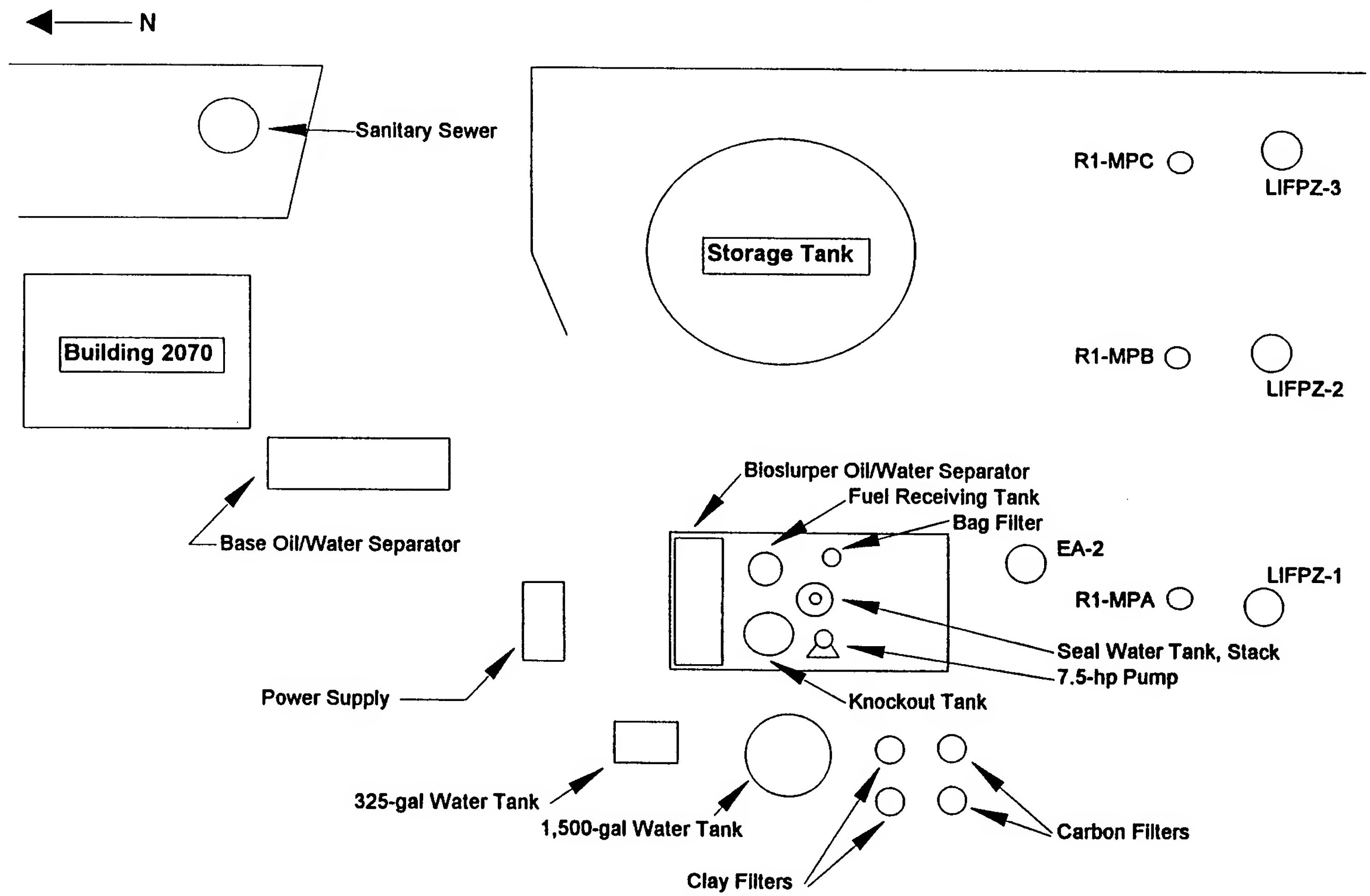

Figure 1. Locations of Groundwater Monitoring Wells and Soil Gas Monitoring Points at Site UST 70/72, Robins AFB, GA

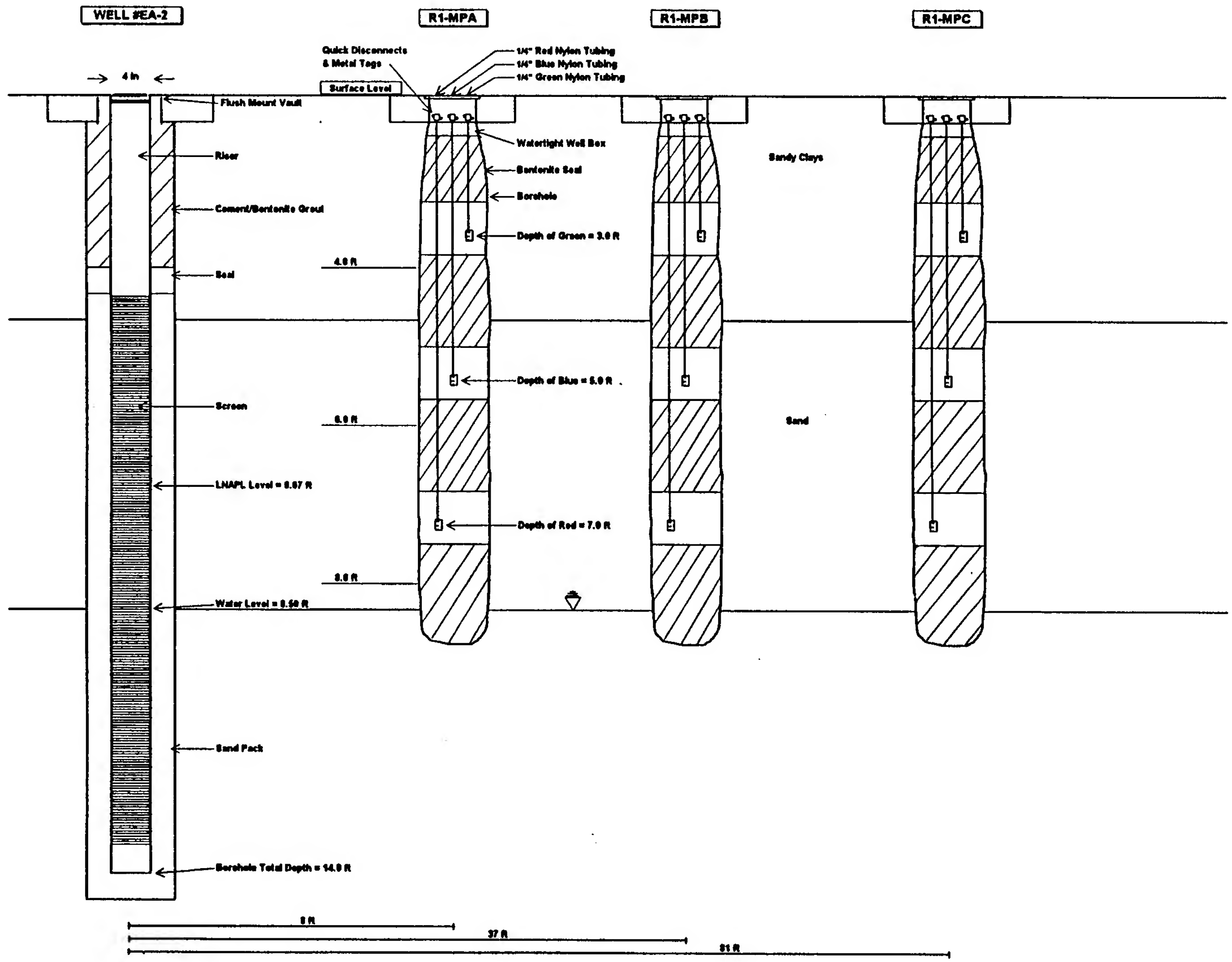

Figure 2. Schematic Diagram Illustrating Site Lithology and Construction Details of the Bioslurper Well and Soil Gas Monitoring Points at Site UST 70/72, Robins AFB, GA

2.2.3 Soil Gas Monitoring Point and Thermocouple Installation

On July 22, 1995, three monitoring points were installed in the area of monitoring well EA-2 and were labeled R1-MPA, R1-MPB, and R1-MPC. The locations and construction details of the monitoring points are illustrated in Figures 1 and 2, respectively.

The monitoring points consisted of sets of ¼-inch tubing, with 1-inch-diameter, 6-inch-long screened areas. The screened lengths were positioned at the appropriate depths, and the annular space corresponding to each screened length was filled with silica sand. The interval between the screened lengths was filled with bentonite clay chips, as was the space from the top of the shallowest screened length to the ground surface. After placement, the bentonite clay was hydrated with water to expand the chips and provide a seal.

All monitoring points were installed in a 6-inch-diameter borehole to a depth of 8.0 ft. Screened lengths were placed at three depths: 2.5 to 3.0 ft, 4.5 to 5.0 ft, and 6.5 to 7.0 ft.

After installation of the monitoring points, initial soil gas measurements were taken with a GasTechtor portable O_2/CO_2 meter and a GasTech Trace-Techtor portable hydrocarbon meter. Oxygen limitation was observed only at the deeper depths, with oxygen concentrations ranging from 1.5% to 2.0% and total petroleum hydrocarbons (TPH) >20,000 ppmv at a depth of 7.0 ft (Table 1).

Table 1. Initial Soil Gas Compositions at Site UST 70/72, Robins AFB, GA

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppmv)
R1-MPA	3.0	20.9	0.5	20
	5.0	19.5	2.1	360
	7.0	2.0	12.5	>20,000
R1-MPB	3.0	20.9	0.3	10
	5.0	17.8	2.1	370
	7.0	1.7	12.5	>20,000
R1-MPC	3.0	20.9	0.1	0
	5.0	17.5	2.8	290
	7.0	1.5	15.1	>20,000

2.2.4 Soil Sampling and Analysis

Two soil samples were collected during the installation of monitoring point R1-MPA. The soil samples were collected in brass sleeves driven down the center of the hollow-stem auger used to drill the soil gas monitoring point. The samples were labeled R1-MPA-7.0′-7.5′ and R1-MPA-7.5′-8.0′. The samples were placed in insulated coolers, chain-of-custody records and shipping papers were completed, and the samples were sent to Alpha Analytical, Inc., Sparks, Nevada by overnight express. Both samples were analyzed for BTEX and TPH, while sample R1-MPA-7.0′-7.5′ was analyzed for bulk density, moisture content, and porosity. Laboratory analytical reports are provided in Appendix B.

2.2.5 LNAPL Recovery Testing

2.2.5.1 System Setup

The bioslurping pilot test system is a trailer-mounted mobile unit. The vacuum pump (Atlantic Fluidics Model A100, 7.5-hp liquid ring pump), oil/water separator, and required support equipment are carried to the test location on a trailer. The trailer was located near monitoring well EA-2, the well cap was removed, a coupling and tee were attached to the top of the well, and the slurper tube was lowered into the well. The slurper tube was attached to the vacuum pump. Different configurations of the tee and the placement depth of the slurper tube allow for simulation of skimmer pumping, operation in the bioslurping configuration, or simulation of drawdown pumping as described in Sections 2.2.5.2, 2.2.5.3, and 2.2.5.5, respectively. Extracted groundwater was treated to control emulsion formation by passing the effluent through a knockout tank, a bag filter, an oil/water separator, and hydrophobic clay drums (Figure 3). Activated carbon drums were added at the end of the treatment train to reduce contaminant concentrations.

A brief system startup test was performed prior to LNAPL recovery testing to ensure that all system components were working properly. The system checklist is provided in Appendix C. All site data and field testing information were recorded in a field notebook and then transcribed onto pilot test data sheets provided in Appendix D.

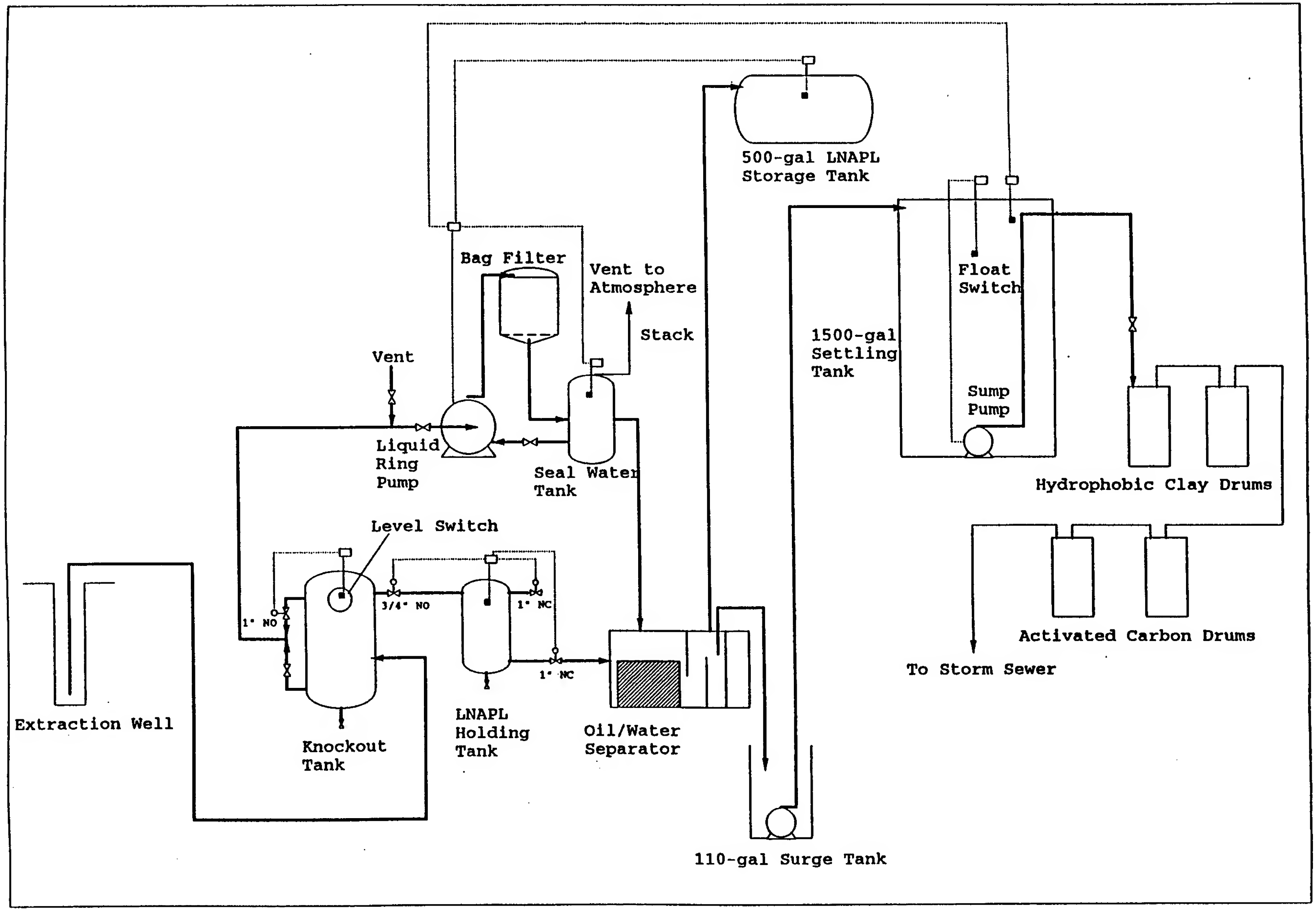

Figure 3. Components of the Emulsion Control and Groundwater Treatment System Used at Site UST 70/72, Robins AFB, GA

2.2.5.2 Initial Skimmer Pump Test

Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface with the wellhead open to the atmosphere via a PVC connecting tee (Figure 4). The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on August 1, 1995, to begin the skimmer pump test. The test was operated continuously for approximately 40 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the skimmer pump test. Test data sheets are provided in Appendix D.

2.2.5.3 Bioslurper Pump Test

Upon completion of the skimmer pump test, preparations were made to begin the bioslurper pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface, as in the skimmer pump test. However, in contrast to the skimmer pump test, the PVC connecting tee was removed, sealing the wellhead and allowing the pump to establish a vacuum in the well (Figure 5). A pressure gauge was installed at the wellhead to measure the vacuum inside the extraction well. The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on August 3, 1995, to begin the bioslurper pump test. The test was initiated approximately 2.5 hours after the skimmer pump test and was operated continuously for approximately 94 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. Test data sheets are provided in Appendix D.

2.2.5.4 Second Skimmer Pump Test

Upon completion of the bioslurper pump test, preparations were made to begin the second skimmer pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The

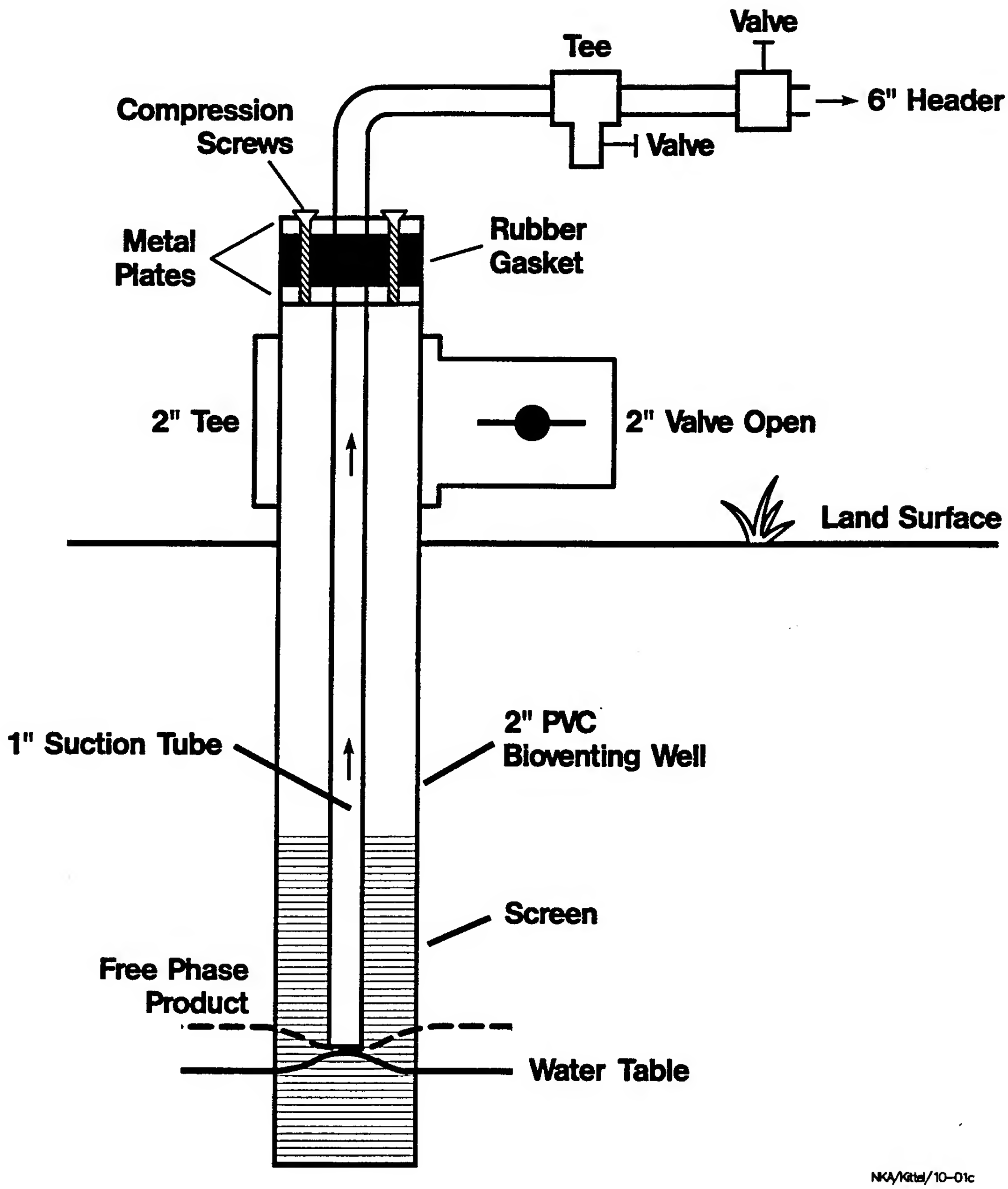

Figure 4. Slurper Tube Placement and Valve Position for the Skimmer Pump Test

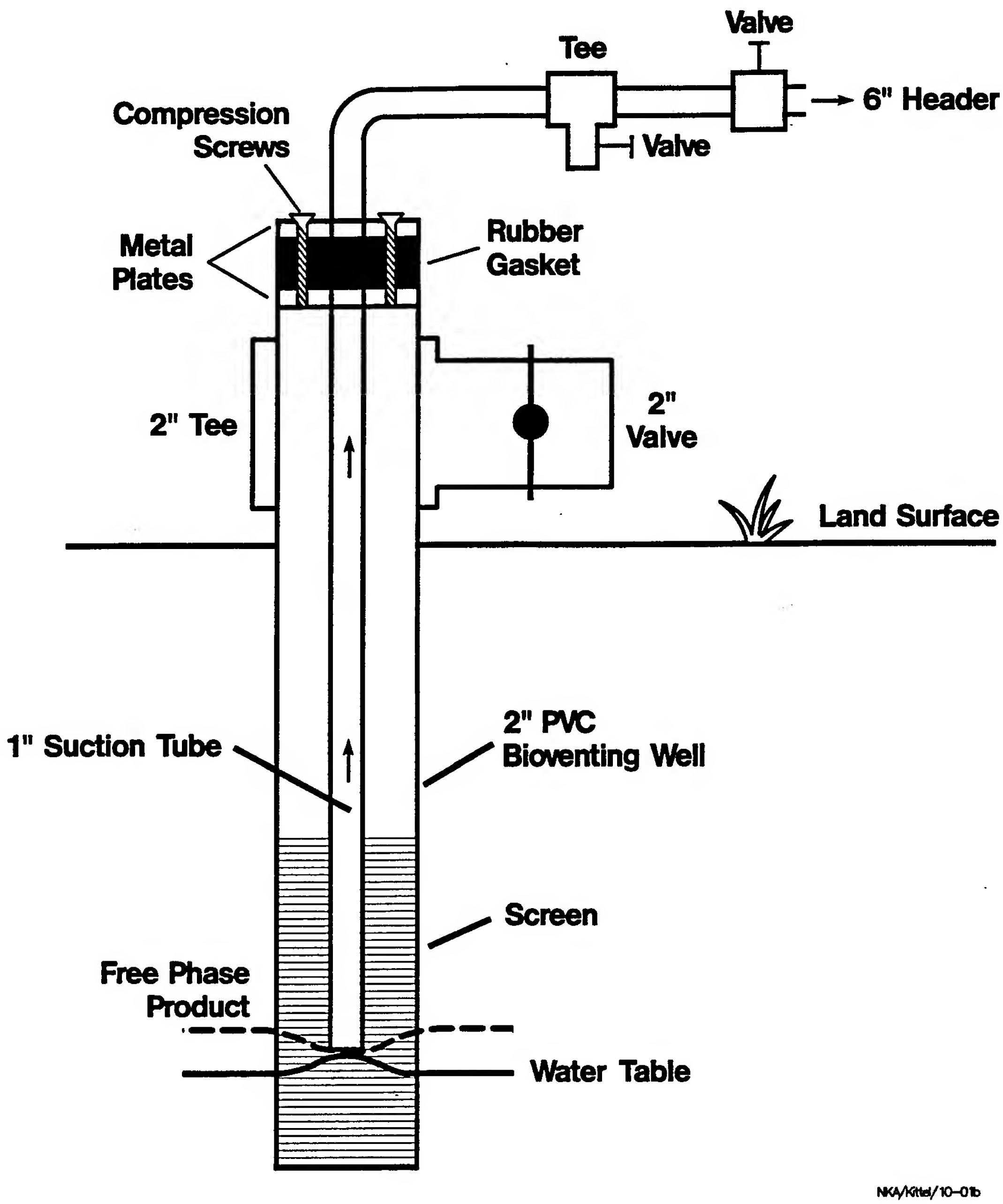

Figure 5. Slurper Tube Placement and Valve Position for the Bioslurper Pump Test

valve and slurper tube configuration were identical to that used for the initial skimmer pump test. The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on August 8, 1995, to begin the second skimmer pump test. The test was initiated approximately 1.5 hours after the bioslurper pump test and was operated continuously for 22 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. Test data sheets are provided in Appendix D.

2.2.5.5 Drawdown Pump Test

Upon completion of the second skimmer pump test, preparations were made to begin the drawdown pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set so that the tip was 24 inches below the oil/water interface with the PVC connecting tee open to the atmosphere (Figure 6). The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on August 9, 1995, to begin the drawdown pump test. The test was initiated approximately 2 hours after the second skimmer pump test and was operated continuously for 22 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the drawdown pump test. Test data sheets are provided in Appendix D.

2.2.5.6 Off-Gas Sampling and Analysis

Soil gas samples were collected from the bioslurper off-gas during the bioslurper pump test. Samples were collected in Summa™ canisters during the first and third day after test initiation and were labeled R1-Stack-1 and R1-Stack-2, respectively. The samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

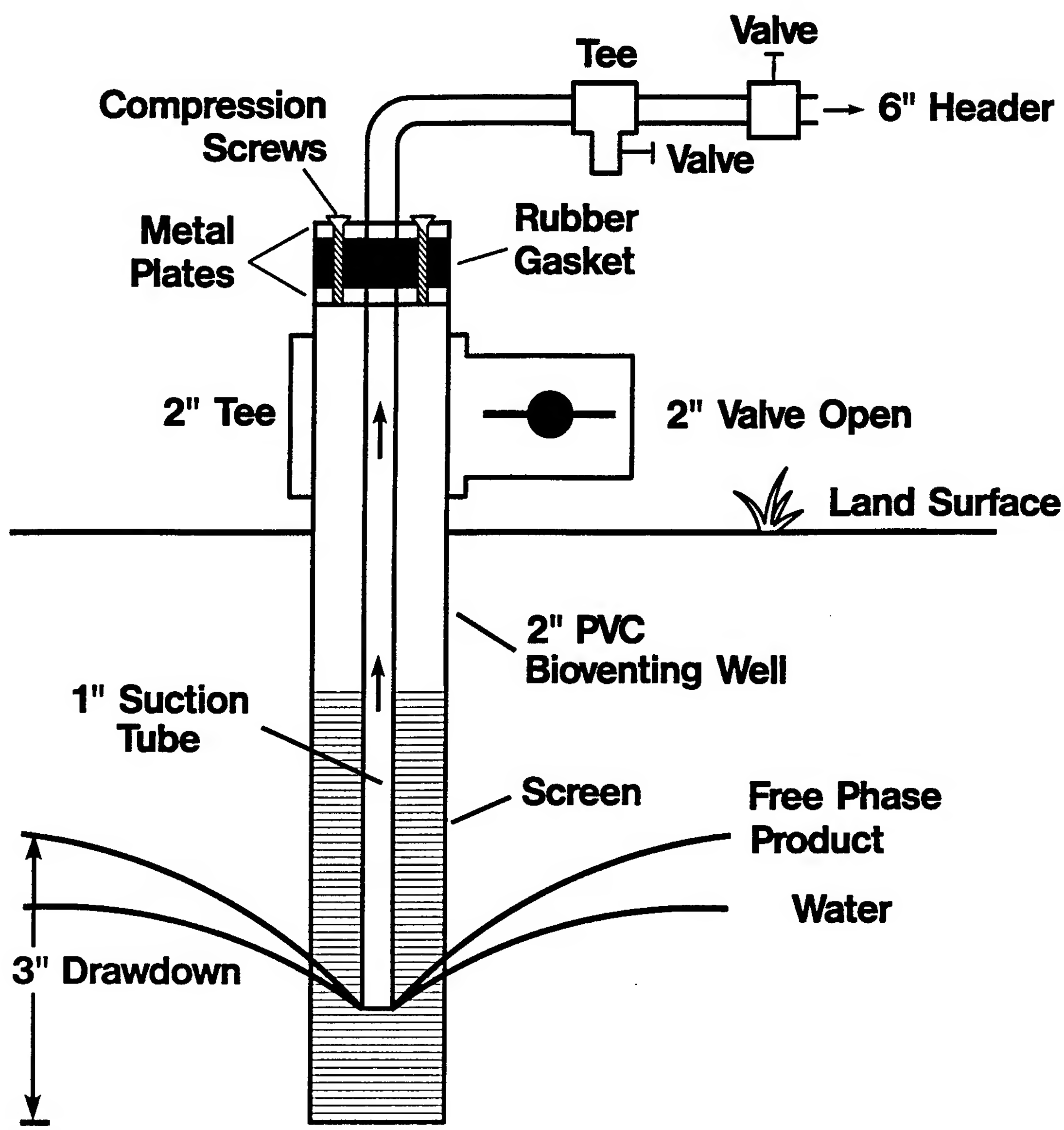

Figure 6. Slurper Tube Placement and Valve Position for the Drawdown Pump Test

2.2.5.7 Groundwater Sampling and Analysis

Seven groundwater samples were collected during the bioslurper pump test. One sample was collected from the oil/water separator (R1-H2O-1), one sample was collected from the 1,500-gallon tank (R1-H2O-2), one sample was collected after the second clay unit (R1-H2O-3), and four samples were collected after the second carbon treatment unit (R1-H2O-4, R1-OutH2O-1, R1-OutH2O-2, and R1-OutH2O-3). Samples were collected in 40-mL septa vials containing HCl preservative. Samples were checked to ensure no headspace was present and were then shipped on ice and sent under chain of custody to Lubrication Analysts, Inc., in Albany, Georgia for analyses of BTEX and TPH.

2.2.6 Soil Gas Permeability Testing

The soil gas permeability test data were collected during the bioslurper pump test. Before a vacuum was established in the extraction well, the initial soil gas pressures at the three installed monitoring points were recorded. The start of the bioslurper pump test created a steep pressure drop in the extraction well which was the starting point for the soil gas permeability testing. Soil gas pressures were measured at each of the three monitoring points at all depths to track the rate of outward propagation of the pressure drop in the extraction well. Soil gas pressure data were collected frequently during the first 20 minutes of the test. The soil gas pressures were recorded throughout the bioslurper pump test to determine the bioventing radius of influence. Test data are provided in Appendix E.

2.2.7 In Situ Respiration Testing

Air containing approximately 1% helium was injected into three monitoring points for approximately 24 hours beginning on August 9, 1995. The setup for the in situ respiration test is described in the *Test Plan and Technical Protocol a Field Treatability Test for Bioventing* (Hinchee et al., 1992). A ½-hp diaphragm pump was used for air and helium injection. Air and helium were injected through the following monitoring points at the depths indicated: R1-MPA-7.0′, R1-MPB-7.0′, and R1-MPC-7.0′. After the air/helium injection was terminated, soil gas concentrations of oxygen, carbon dioxide, TPH, and helium were monitored periodically. The respiration test was

terminated on August 13, 1995. Oxygen utilization and biodegradation rates were calculated as described in Hinchee et al. (1992). Raw data for these tests are presented in Appendix F.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributable to either diffusion through the soil or leakage. A rapid drop in helium concentration usually indicates leakage. A gradual loss of helium along with a first-order curve generally indicates diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses approximately 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations at test completion are at least 50 to 60% of the initial levels, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

2.3 Results

This section documents the results of the site characterization, the comparative LNAPL recovery pump test, and other supporting tests conducted at Robins AFB.

2.3.1 Baildown Test Results

Results from the baildown test in monitoring well EA-2 are presented in Table 2. A total volume of 5.8 L (1.5 gallons) was removed by hand bailing from monitoring well EA-2. The LNAPL thickness recovered rapidly to approximately initial levels by the end of the 22-hour test period. These results indicated that monitoring well EA-2 was suitable for bioslurper field testing.

2.3.2 Soil Sample Analyses

Table 3 shows the BTEX and TPH concentrations measured in soil samples collected from Site UST 70/72. BTEX and TPH concentrations were high, with an average total BTEX concentration of 220 mg/kg and an average TPH concentration of 25,000 mg/kg. Results of the physical characterization of the soils showed a moisture content of 9.6%, a bulk density of 1.21 g/cm^3, a porosity of 54.3%, and particle size of 91% sand, 4.0% silt, and 5.0% clay.

Table 2. Results of Baildown Testing in Monitoring Well EA-2, Site UST 70/72, Robins AFB, GA

Date-Time	Depth to LNAPL (ft)	Depth to Groundwater (ft)	LNAPL Thickness (ft)
Initial Reading 7/20/95-0830	6.67	8.50	1.83
Test Initiation 7/20/95-0850	6.78	8.09	1.31
7/20/95-0900	6.67	8.35	1.68
7/20/95-0910	6.67	8.38	1.71
7/20/95-0920	6.67	8.40	1.73
7/20/95-1154	6.67	8.45	1.78
7/20/95-1616	6.67	8.47	1.80
7/21/95-0656	6.67	8.50	1.83

Table 3. BTEX and TPH Concentrations in Soil Samples from Site UST 70/72, Robins AFB, GA

Parameter	Concentration (mg/kg)	
	R1-MPA-7.0′-7.5′	R1-MPA-7.5′-8.0′
TPH	31,000	19,000
Benzene	13	14
Toluene	19	15
Ethylbenzene	31	24
Xylenes	190	140

2.3.3 LNAPL Pump Test Results

2.3.3.1 Initial Skimmer Pump Test Results

The LNAPL thickness prior to the initial skimmer pump test was 1.82 ft (Table 4). A total of 18.2 gallons of LNAPL was recovered during this test, with an average recovery rate of 11 gallons/day (Table 5). A total of 1,420 gallons of groundwater was extracted with an average extraction rate of 850 gallons/day (Table 5). Results of LNAPL recovery versus time are shown in Figure 7.

2.3.3.2 Bioslurper Pump Test Results

LNAPL recovery rates increased significantly during the bioslurper pump test (Figure 7). The increase in recovery rate indicates that LNAPL was mobilized to the extraction well under vacuum-enhanced conditions. A total of 186 gallons of LNAPL and 5,425 gallons of groundwater was extracted during the bioslurper pump test, with an average recovery rate of 48 gallons/day for LNAPL and 1,400 gallons/day for groundwater (Table 5). The LNAPL recovery rate versus time is shown in Figure 8. The vacuum-exerted wellhead pressure on monitoring well EA-2 was kept relatively constant throughout the bioslurper pump test at approximately 25 inches of mercury.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Oxygen concentrations increased slightly at monitoring points R1-MPA-7.0′ and R1-MPB-7.0′, but not at all at R1-MPC-7.0′ (Table 6). These results correlate with radius of influence results from the soil gas permeability test.

2.3.3.3 Second Skimmer Pump Test

Totals of 4.6 gallons of LNAPL and 697 gallons of groundwater were recovered during the second skimmer pump test, with average recovery rates of 5.0 gallons/day for LNAPL and 750 gallons/day for groundwater (Table 5). These results demonstrate that operation of the bioslurper system in the skimmer mode was not as effective a means of free-product recovery as the bioslurper system at this site.

Table 4. Depths to Groundwater and LNAPL Prior to Each Pump Test

Test	Test Start Date	Depth to LNAPL (ft)	Depth to Groundwater (ft)[1]	LNAPL Thickness (ft)
Initial Skimmer Pump Test	8/1/95	6.67	8.49	1.82
Bioslurper Pump Test	8/3/95	6.80	7.35	0.55
Second Skimmer Pump Test	8/7/95	6.95	7.26	0.31
Drawdown Pump Test	8/8/95	6.90	7.15	0.25

Table 5. Pump Test Results at Site UST 70/72, Robins AFB, GA

Recovery Rate (gal/day)	Initial Skimmer Pump Test		Bioslurper Pump Test		Second Skimmer Pump Test		Drawdown Pump Test	
	LNAPL	Groundwater	LNAPL	Groundwater	LNAPL	Groundwater	LNAPL	Groundwater
Day 1	16	750	64	1,440	8.6	750	12	2,100
Day 2	6.3	930	45	1,520	NA	NA	NA	NA
Day 3	NA	NA	40	1,490	NA	NA	NA	NA
Day 4	NA	NA	40	1,060	NA	NA	NA	NA
Average	11	850	48	1,400	5.0	750	12	2,100
Total Recovered (gal)	18.2	1,420	186.1	5,425	4.6	697	10.5	1,910

NA = Not applicable.

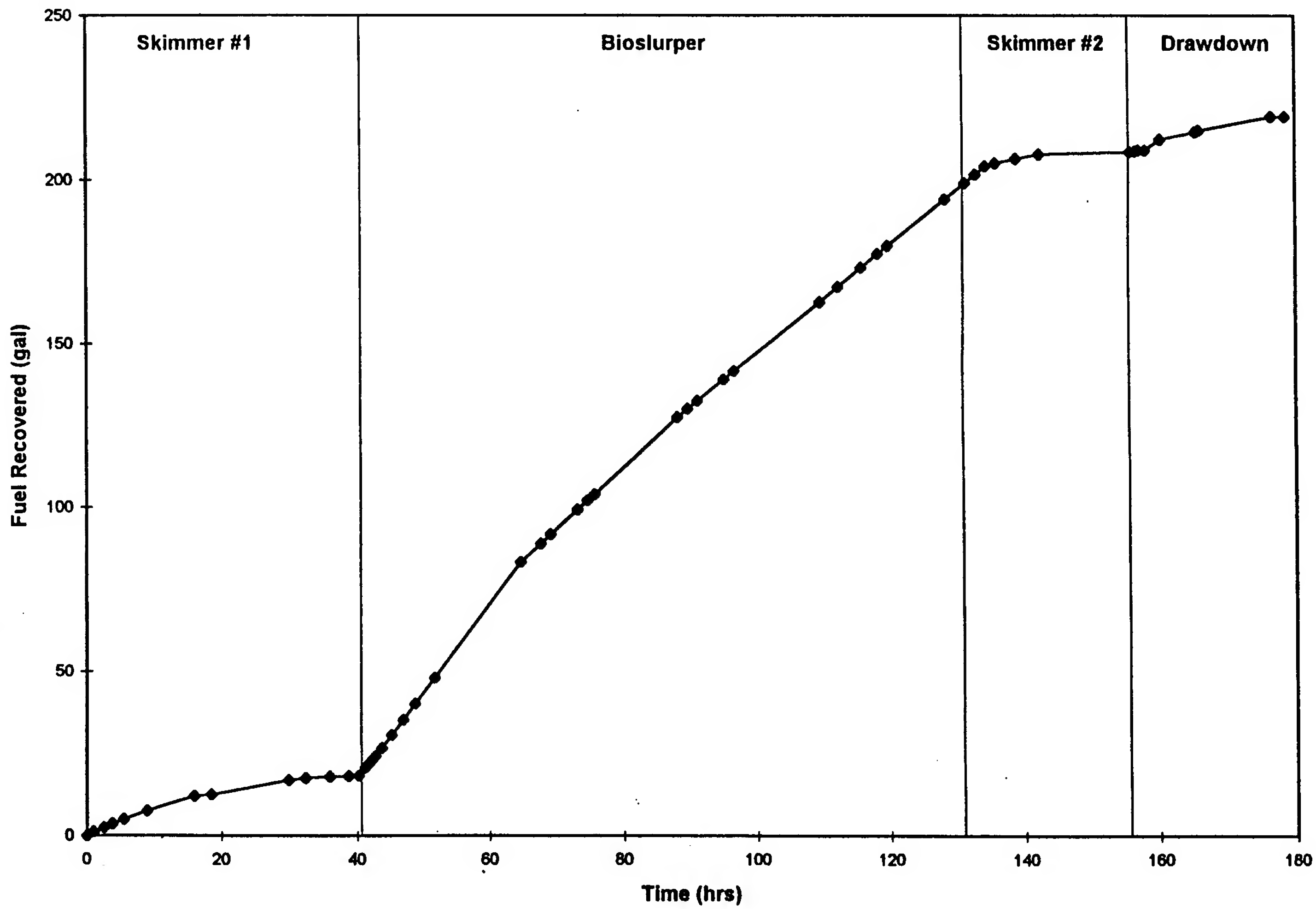

Figure 7. LNAPL Recovery Versus Time During Each Pump Test at Site UST 70/72

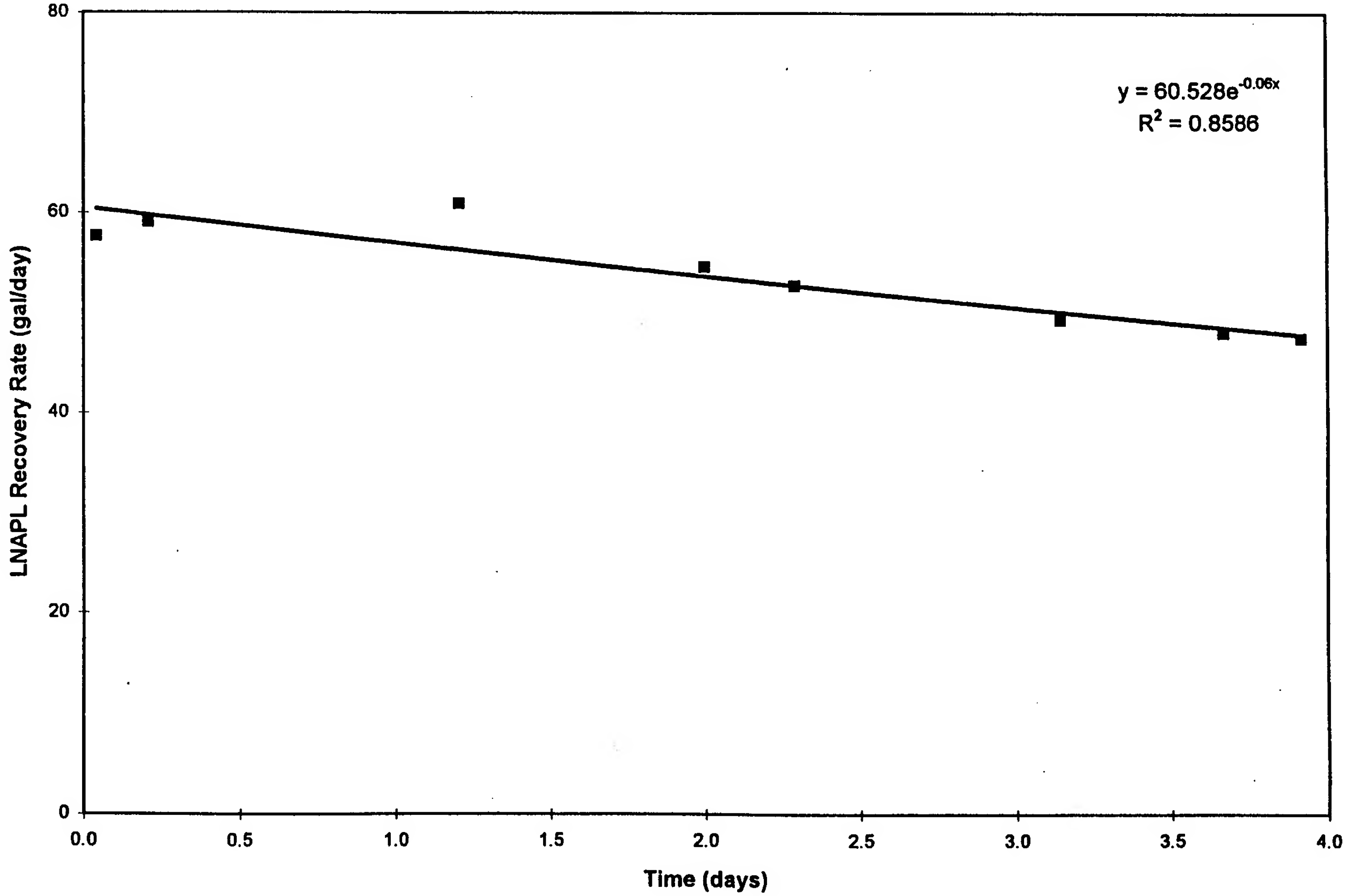

Figure 8. LNAPL Recovery Rate Versus Time During the Bioslurper Pump Test at Site UST 70/72

Table 6. **Oxygen Concentrations During the Bioslurper Pump Test at Site UST 70/72, Robins AFB, GA**

Monitoring Point	Oxygen Concentrations (%) Versus Time (minutes)				
	0	3.5	26	49	90
R1-MPA-3.0′	20.9	20.9	20.9	20.9	20.9
R1-MPA-5.0′	19.5	19.2	19.0	18.5	18.9
R1-MPA-7.0′	2.0	2.5	2.9	4.8	5.1
R1-MPB-3.0′	20.9	20.9	20.9	21.0	21.0
R1-MPB-5.0′	17.8	17.9	18.5	20.9	20.9
R1-MPB-7.0′	1.7	2.0	2.1	2.2	2.5
R1-MPC-3.0′	20.9	20.9	20.9	20.9	20.9
R1-MPC-5.0′	17.5	17.9	17.1	18.9	18.9
R1-MPC-7.0′	1.5	1.7	1.6	1.4	1.6

2.3.3.4 Drawdown Pump Test

Results from the drawdown pump test were similar to those from the skimmer pump tests (Figure 7). A high ratio of LNAPL to groundwater was extracted, with totals of 10.5 gallons of LNAPL and 1,910 gallons of groundwater extracted (Table 5). These results demonstrate that operation of the bioslurper system in the drawdown mode was not as effective a means of free-product recovery as the bioslurper system at this site.

2.3.4 Emulsion Control and Extracted Groundwater, LNAPL, and Off-Gas Analyses

During the skimmer, bioslurper, and drawdown pump tests, the emulsion control system did minimize the formation of the solid fuel/water emulsion; however, the liquid fuel/water emulsion was not affected. Consequently, contaminant concentrations were not significantly reduced by the emulsion control system. Treatment through activated carbon resulted in BTEX and TPH concentrations reduced to below detection limits (Table 7).

Table 7. **BTEX and TPH Concentrations in Extracted Groundwater During the Bioslurper Pump Test at Site UST 70/72, Robins AFB, GA**

Parameter	Concentration (mg/L)				
	TPH	Benzene	Toluene	Ethylbenzene	Total Xylenes
R1-H2O-1	22	0.13	0.092	0.092	0.22
R1-H2O-2	29	0.30	0.33	0.13	0.18
R1-H2O-3	20	0.22	0.18	0.043	0.27
R1-H2O-4	<0.50	<0.00050	<0.00050	<0.00050	<0.00050
R1-OutH2O-1	<0.50	<0.0010	<0.0010	<0.0010	<0.0010
R1-OutH2O-2	<0.50	<0.0010	<0.0010	<0.0010	<0.0010
R1-OutH2O-3	<0.50	<0.0010	<0.0010	<0.0010	<0.0010

Off-gas samples from the bioslurper system also were collected during the bioslurper pump test. The results from the off-gas analyses are presented in Table 8. Given a vapor discharge rate of 5 scfm and using an average concentration of 37,000 ppmv TPH, approximately 110 lb/day of TPH was emitted to the air during the bioslurper pump test. Benzene emissions were approximately 0.74 lb/day.

The composition of LNAPL is shown in Tables 9 and 10 in terms of BTEX concentrations and distribution of C-range compounds, respectively. The distribution of C-range compounds is shown graphically in Figure 9.

2.3.5 Bioventing Analyses

2.3.5.1 Soil Gas Permeability and Radius of Influence

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the extraction well. The radius of influence is then defined as the distance from the extraction well where 0.1 inch of H_2O can be measured. Based on this definition, the radius of influence at this site is approximately 57 ft (Figure 10).

Table 8. **BTEX and TPH Concentrations in Off-Gas During the Bioslurper Pump Test at Site UST 70/72, Robins AFB, GA**

Parameter	Concentration (ppmv)	
	R1-Stack-1	R1-Stack-2
TPH as jet fuel	27,000	47,000
Benzene	370	660
Toluene	140	260
Ethylbenzene	20	43
Xylenes	65	130

Table 9. BTEX Concentrations in LNAPL from Site UST 70/72, Robins AFB, GA

Compound	Concentration (mg/kg)
Benzene	460
Toluene	1,600
Ethylbenzene	7,200
Total Xylenes	1,100

Table 10. C-Range Compounds in LNAPL from Site UST 70/72, Robins AFB, GA

C-Range Compound	Percentage of Total
<C9	17.33
C10	28.09
C11	19.14
C12	12.48
C13	10.31
C14	6.60
C15	3.53
C16	1.59
>C17	0.93

2.3.5.2 In Situ Respiration Test Results

Results from the in situ respiration test are presented in Table 11. Oxygen depletion was relatively rapid, with oxygen utilization rates ranging from 0.11 to 0.20% O_2/hr. Biodegradation rates ranged from 1.8 to 3.2 mg/kg-day. The helium concentration was steady, indicating that leakage and diffusion were insignificant.

2.4 Discussion

Skimmer pumping was not as effective as bioslurping at recovering LNAPL from this site. Free-product recovery rates remained relatively low during skimmer pumping, at an average recovery rate of 11 gallons/day during the initial skimmer pump test and decreasing to 5.0 gallons/day by the end of the second skimmer pump test. In contrast, free-product recovery rates during the bioslurper pump test remained relatively stable after the first day of operation at approximately 40 gallons/day. Drawdown pumping resulted in only slightly higher recovery than skimmer pumping and much less than bioslurping, with an average recovery rate of 12 gallons/day.

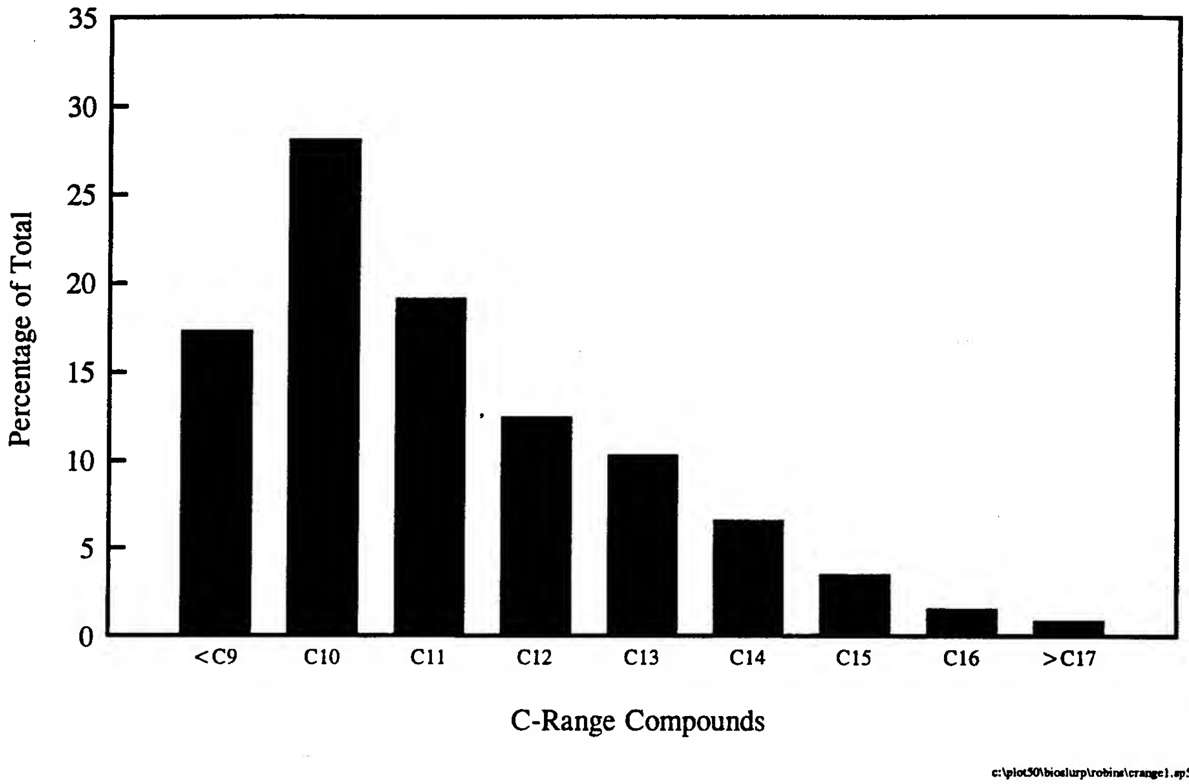

Figure 9. Distribution of C-Range Compounds in Extracted LNAPL at Site UST 70/72, Robins AFB, GA

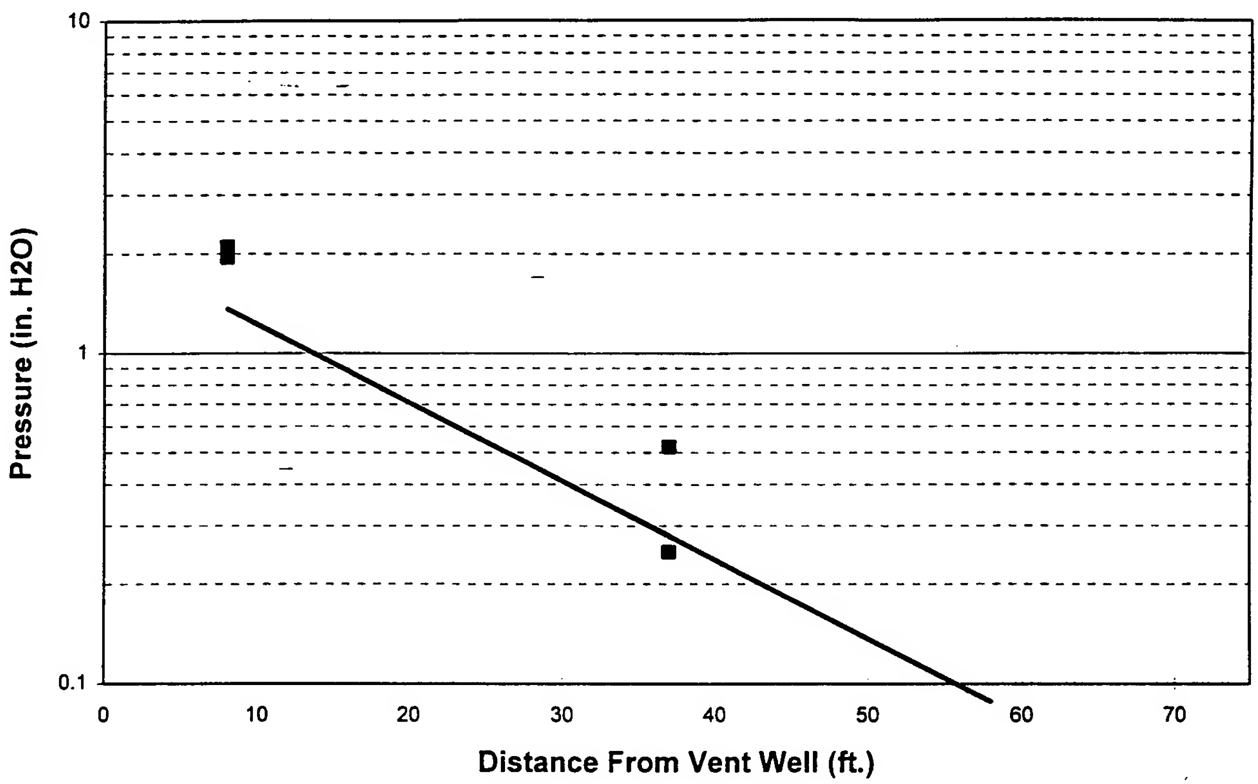

Figure 10. **Soil Gas Pressure Change as a Function of Distance During the Soil Gas Permeability Test at Site UST 70/72**

Table 11. In Situ Respiration Test Results at Site UST 70/72, Robins AFB, GA

Monitoring Point	Oxygen Utilization Rate (%/hr)	Biodegradation Rate (mg/kg-day)
R1-MPA-7.0′	0.18	2.9
R1-MPB-7.0′	0.20	3.2
R1-MPC-7.0′	0.11	1.8

Groundwater recovery rates during the bioslurper pump test were high in comparison to rates during the skimmer or drawdown pump tests. On average, groundwater was extracted at rates of 5,400 gallons/day during bioslurping, compared to ~~1,400~~ 850 and 1,900 2100 gallons/day during skimming and drawdown pumping, respectively.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Monitoring points at depths of 3.0 and 5.0 ft were not oxygen-limited. Oxygen concentrations increased slightly at monitoring points R1-MPA-7.0′ and R1-MPB-7.0′, but not at all at R1-MPC-7.0′. These results correlate with radius of influence results from the soil gas permeability test, where a radius of influence of approximately 57 ft was calculated. Given the low permeability of the soil, it is unlikely that soils would be oxygenated fully during the short time period of the soil gas permeability test. However, over time, it is likely that soils within the radius of influence of the bioslurper well will become oxygenated.

Implementation of bioslurping at the Robins AFB test site probably would facilitate enhanced recovery of LNAPL from the water table and simultaneous in situ biodegradation of hydrocarbons in the vadose zone via bioventing. An extended bioslurper test is planned for this site. The bioslurper system will be configured to tie into the bioslurper test well and into existing wells on-site.

3.0 SITE SS010

3.1 Site Description

Site SS010, located in Zone 4 at Robins AFB, consists of JP-4 fuel storage tanks that are supplied by a pipeline running from the Standard Transmission Corporation Tank Farm located to the north of Robins AFB. Two major spills have occurred since the mid-1960s and recent site characterization studies have shown that a large LNAPL plume is present at Site SS010.

Figure 11 illustrates the locations of monitoring wells at Site SS010. Several monitoring wells have routinely contained significant thicknesses of free product.

3.2 Bioslurper Short-Term Pilot Test Methods

This section documents the initial conditions at the test site and describes the test equipment and methods used for the short-term pilot test at Robins AFB.

3.2.1 Initial LNAPL/Groundwater Measurements and Baildown Testing

Monitoring wells LF-1-3 and PZ-1 were evaluated for use in the bioslurper pilot testing. Initial depths to LNAPL and to groundwater were measured using an oil/water interface probe (ORS Model #1068013). LNAPL was removed from the wells with a Teflon™ bailer until the LNAPL thickness could no longer be reduced. The rate of increase in the thickness of the floating LNAPL layer was monitored for approximately 66 hours using the oil/water interface probe.

An LNAPL sample was collected from monitoring well LF-1-3 after completing the baildown test and was labeled R2-Fuel-1. The sample was sent to Alpha Analytical, Inc., Sparks, Nevada for analyses of BTEX and boiling point fractionation.

3.2.2 Well Construction Details

Existing monitoring well LF-1-3 was selected for use in the bioslurper pilot testing. The well is constructed of 2-inch-diameter, schedule 40 PVC with a total depth of 25 ft and 20 ft of screen. A schematic diagram illustrating the well construction details is provided in Figure 12.

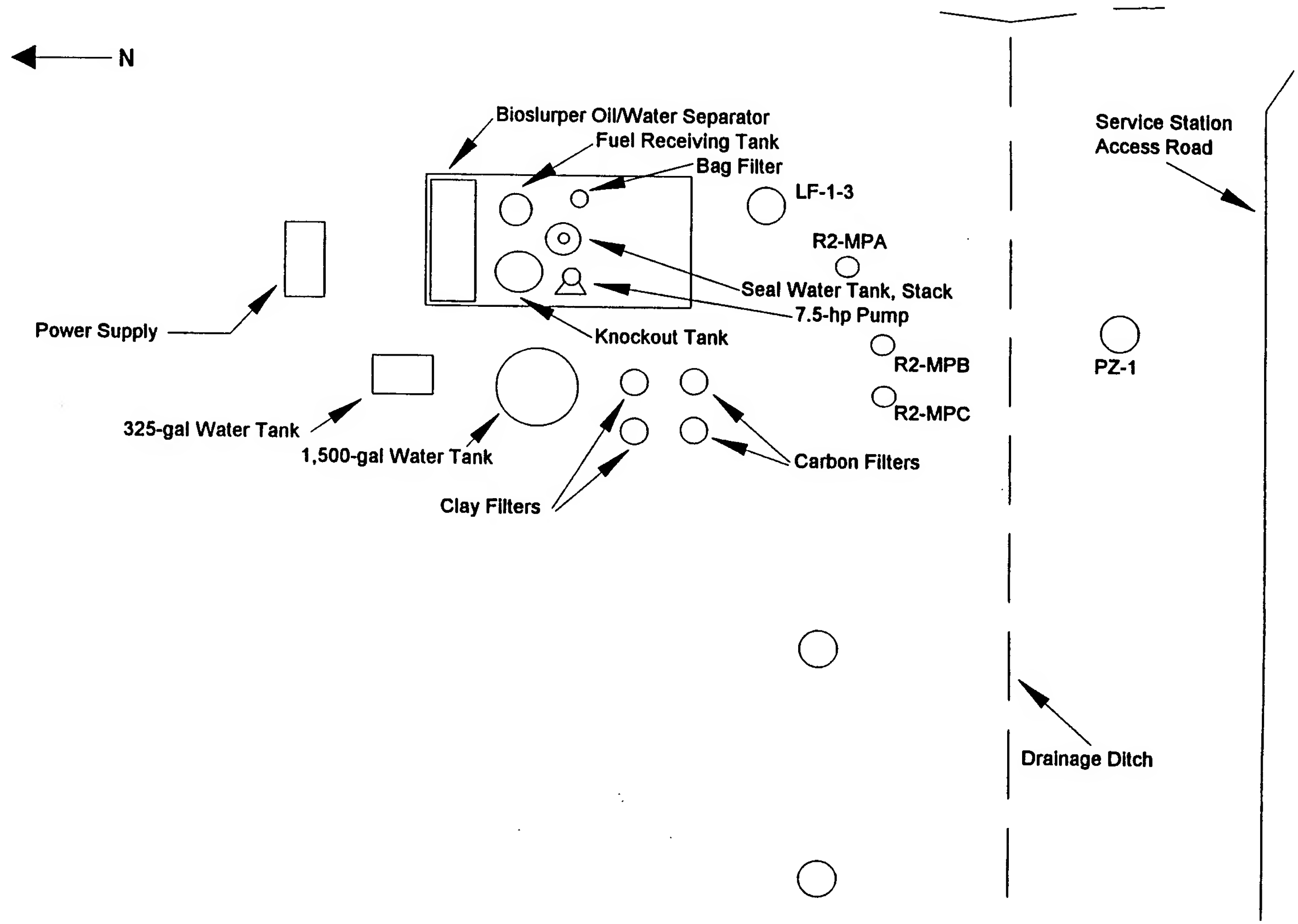

Figure 11. Locations of Groundwater Monitoring Wells and Soil Gas Monitoring Points at Site SS010, Robins AFB, GA

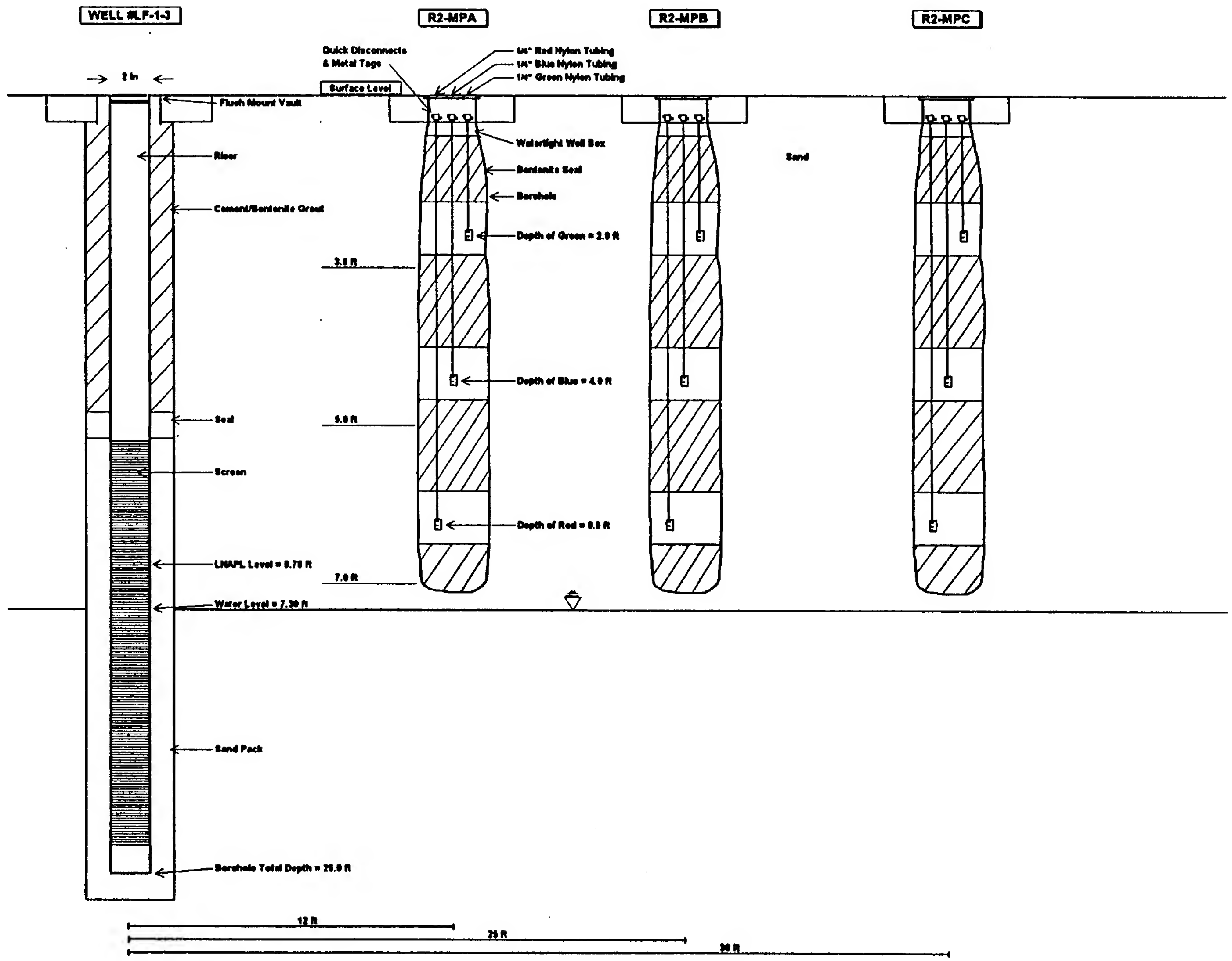

Figure 12. Schematic Diagram Illustrating Site Lithology and Construction Details of the Bioslurper Well and Soil Gas Monitoring Points at Site SS010, Robins AFB, GA

3.2.3 Soil Gas Monitoring Point and Thermocouple Installation

On July 22, 1995, three monitoring points were installed in the area of monitoring well LF-1-3 and were labeled R2-MPA, R2-MPB, and R2-MPC. The locations and construction details of the monitoring points are illustrated in Figures 11 and 12, respectively.

The monitoring points consisted of sets of ¼-inch tubing, with 1-inch-diameter, 6-inch-long screened areas. The screened lengths were positioned at the appropriate depths, and the annular space corresponding to the screened length was filled with silica sand. The interval between the screened lengths was filled with bentonite clay chips, as was the space from the top of the shallowest screened length to the ground surface. After placement, the bentonite clay was hydrated with water to expand the chips and provide a seal.

All monitoring points were installed in a 6-inch-diameter borehole to a depth of 7.0 ft. Screened lengths were placed at three depths: 1.5 to 2.0 ft, 3.5 to 4.0 ft, and 5.5 to 6.0 ft.

After installation of the monitoring points, initial soil gas measurements were taken with a GasTechtor portable O_2/CO_2 meter and a GasTech Trace-Techtor portable hydrocarbon meter. In general, oxygen limitation was observed at the deeper depths, with oxygen concentrations ranging from 5.2% to 9.8% at a depth of 4.0 ft (Table 12). Soil gas concentrations could not be measured at deeper depths due to excess soil moisture.

3.2.4 Soil Sampling and Analysis

Two soil samples were collected during the installation of monitoring point R2-MPA. The soil samples were collected in brass sleeves driven down the center of the hollow-stem auger used to drill the monitoring well. The samples were labeled as follows: R2-MPA-6.0′-6.5′ and R2-MPA-6.5′-7.0′. The samples were placed in insulated coolers, chain-of-custody records and shipping papers were completed, and the samples were sent to Alpha Analytical, Inc., in Sparks, Nevada by overnight express. Both samples were analyzed for BTEX and TPH. Sample R2-MPA-6.0′-6.5′ also was analyzed for bulk density, moisture content, and porosity. Laboratory analytical reports for all samples are provided in Appendix B.

Table 12. Initial Soil Gas Compositions at Site SS010, Robins AFB, GA

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppmv)
R2-MPA	2.0	19.8	1.7	400
	4.0	5.2	8.9	>10,000
	6.0	ND	ND	ND
R2-MPB	2.0	19.5	2.1	460
	4.0	9.5	7.8	5,800
	6.0	ND	ND	ND
R2-MPC	2.0	15.7	4.6	580
	4.0	9.8	9.5	7,000
	6.0	ND	ND	ND

ND Not determined. Excess soil moisture prohibited soil gas collection at this depth.

3.2.5 LNAPL Recovery Testing

3.2.5.1 System Setup

The bioslurping pilot test system is a trailer-mounted mobile unit. The vacuum pump (Atlantic Fluidics Model A100, 7.5-hp liquid ring pump), oil/water separator, and required support equipment are carried to the test location on a trailer. The trailer was located near monitoring well LF-1-3, the well cap was removed, a coupling and tee were attached to the top of the well, and the slurper tube was lowered into the well. The slurper tube was attached to the vacuum pump. Different configurations of the tee and the placement depth of the slurper tube allow for simulation of skimmer pumping, operation in the bioslurping configuration, or simulation of drawdown pumping as described in Sections 3.2.5.2, 3.2.5.3, and 3.2.5.5, respectively. Extracted groundwater was treated to control emulsion formation by passing the effluent through a knockout tank, a bag filter, an oil/water separator, and hydrophobic clay drums (Figure 3). Activated carbon drums were added at the end of the treatment train to reduce contaminant concentrations.

A brief system startup test was performed prior to LNAPL recovery testing to ensure that all system components were working properly. The system checklist is provided in Appendix C. All site data and field testing information were recorded in a field notebook and then transcribed onto pilot test data sheets provided in Appendix D.

3.2.5.2 Initial Skimmer Pump Test

Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface with the wellhead open to the atmosphere via a PVC connecting tee (Figure 4). The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on August 10, 1995, to begin the skimmer pump test. The test was operated continuously for approximately 43 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the skimmer pump test. Test data sheets are provided in Appendix D.

3.2.5.3 Bioslurper Pump Test

Upon completion of the skimmer pump test, preparations were made to begin the bioslurper pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface, as in the skimmer pump test. However, in contrast to the skimmer pump test, the PVC connecting tee was removed, sealing the wellhead and allowing the pump to establish a vacuum in the well (Figure 5). A pressure gauge was installed at the wellhead to measure the vacuum inside the extraction well. The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on August 12, 1995, to begin the bioslurper pump test. The test was initiated approximately 2.5 hours after the skimmer pump test and was operated continuously for approximately 86 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. Test data sheets are provided in Appendix D.

3.2.5.4 Drawdown Pump Test

Upon completion of the bioslurper pump test, preparations were made to begin the drawdown pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set so that the tip was 24 inches below the oil/water interface with the PVC connecting tee open to the atmosphere (Figure 6). The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on August 16, 1995, to begin the drawdown pump test. The test was initiated approximately 2 hours after the bioslurper pump test and was operated continuously for 33 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the drawdown pump test. Test data sheets are provided in Appendix D.

3.2.5.5 Off-Gas Sampling and Analysis

Soil gas samples were collected from the bioslurper off-gas during the bioslurper pump test. Samples were collected in Summa™ canisters during the first and third day after test initiation and were labeled R2-Stack-1 and R2-Stack-2, respectively. The samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

3.2.5.6 Groundwater Sampling and Analysis

Six groundwater samples were collected during the bioslurper pump test. One sample was collected from the oil/water separator (R2-H2O-1), one sample was collected from the 1,500-gallon tank (R2-H2O-2), one sample was collected after the second clay unit (R2-H2O-3), and three samples were collected after the second carbon treatment unit (R2-H2O-4, R2-OutH2O-1, and R2-OutH2O-2). Samples were collected in 40-mL septa vials containing HCl preservative. Samples were checked to ensure no headspace was present and were then shipped on ice and sent under chain of custody to Lubrication Analysts, Inc., in Albany, Georgia for analyses of BTEX and TPH.

3.2.6 Soil Gas Permeability Testing

The soil gas permeability test data were collected during the bioslurper pump test. Before a vacuum was established in the extraction well, the initial soil gas pressures at the three installed monitoring points were recorded. The start of the bioslurper pump test created a steep pressure drop in the extraction well which was the starting point for the soil gas permeability testing. Soil gas pressures were measured at each of the three monitoring points at all depths to track the rate of outward propagation of the pressure drop in the extraction well. Soil gas pressure data were collected frequently during the first 20 minutes of the test. The soil gas pressures were recorded throughout the bioslurper pump test to determine the bioventing radius of influence. Test data are provided in Appendix E.

3.2.7 In Situ Respiration Testing

Air containing approximately 1% helium was injected into three monitoring points for approximately 24 hours beginning on August 16, 1995. The setup for the in situ respiration test is described in the *Test Plan and Technical Protocol a Field Treatability Test for Bioventing* (Hinchee et al., 1992). A ½-hp diaphragm pump was used for air and helium injection. Air and helium were injected through the following monitoring points at the depths indicated: R2-MPA-4.0′, R2-MPB-4.0′, and R2-MPC-4.0′. After the air/helium injection was terminated, soil gas concentrations of oxygen, carbon dioxide, TPH, and helium were monitored periodically. The respiration test was terminated on August 20, 1995. Oxygen utilization and biodegradation rates were calculated as described in Hinchee et al. (1992). Raw data for these tests are presented in Appendix F.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributable to either diffusion through the soil or leakage. A rapid drop in helium concentration usually indicates leakage. A gradual loss of helium along with a first-order curve generally indicates diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses approximately 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations at test completion

are at least 50 to 60% of the initial levels, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

3.3 Results

This section documents the results of the site characterization, the comparative LNAPL recovery pump test, and other supporting tests conducted at Site SS010, Robins AFB.

3.3.1 Baildown Test Results

Results from the baildown test in monitoring wells LF-1-3 and PZ-1 are presented in Table 13. A total volume of 1.6 and 0.9 L (0.42 and 0.24 gallons) was removed by hand bailing from monitoring wells LF-1-3 and PZ-1, respectively. The LNAPL thickness recovered relatively slowly to approximately initial levels by the end of the 66-hour test period. Monitoring well LF-1-3 was selected for testing primarily due to the deeper groundwater depth.

3.3.2 Soil Sample Analyses

Table 14 shows the BTEX and TPH concentrations measured in soil samples collected from Site SS010. BTEX and TPH concentrations were relatively high, with an average total BTEX concentration of 11 mg/kg and an average TPH concentration of 420 mg/kg. Results of the physical characterization of the soils showed a moisture content of 17.2%, a bulk density of 1.83 g/cm^3, a porosity of 30.9%, and particle size of 86% sand, 4.0% silt, and 10.0% clay.

3.3.3 LNAPL Pump Test Results

3.3.3.1 Initial Skimmer Pump Test Results

The LNAPL thickness prior to the initial skimmer pump test was 0.48 ft (Table 15). A total of 2.5 gallons of LNAPL was recovered during this test, with an average recovery rate of 1.4 gallons/day (Table 16). A total of 1,550 gallons of groundwater was extracted with an average

Table 13. Results of Baildown Testing in Monitoring Wells PZ-1 and LF-1-3, Site SS010, Robins AFB, GA

Monitoring Well	Date-Time	Depth to LNAPL (ft)	Depth to Groundwater (ft)	LNAPL Thickness (ft)
LF-1-3	Initial Reading 7/22/95-1400	6.78	7.30	0.52
	Test Initiation 7/22/95-1500	6.89	6.91	0.02
	7/22/95-1510	6.87	6.92	0.05
	7/22/95-1520	6.85	6.93	0.08
	7/22/95-1530	6.84	6.93	0.09
	7/22/95-1630	6.83	6.95	0.12
	7/23/95-0445	6.82	6.97	0.15
	7/23/95-0920	6.82	6.97	0.15
	7/23/95-1440	6.81	6.97	0.16
	7/24/95-1415	6.79	7.07	0.28
	7/25/95-0930	6.77	7.22	0.45
PZ-1	Initial Reading 7/22/95-0900	3.90	4.60	0.70
	Test Initiation 7/22/95-1500	4.05	4.06	0.01
	7/22/95-1510	4.05	4.09	0.04
	7/22/95-1520	4.04	4.11	0.07
	7/22/95-1530	4.03	4.11	0.08
	7/22/95-1630	4.03	4.20	0.17
	7/23/95-0500	4.02	4.22	0.20
	7/23/95-0940	4.02	4.24	0.22
	7/23/95-1505	4.00	4.27	0.27
	7/24/95-1420	3.95	4.39	0.44
	7/25/95-0940	3.95	4.20	0.25

Table 14. **BTEX and TPH Concentrations in Soil Samples from Site SS010, Robins AFB, GA**

Parameter	Concentration (mg/kg)	
	R2-MPA-6.0′-6.5′	R2-MPA-6.5′-7.0′
TPH	430	410
Benzene	<0.20	<0.20
Toluene	1.3	1.5
Ethylbenzene	1.3	1.4
Xylenes	8.2	8.9

Table 15. Depths to Groundwater and LNAPL Prior to Each Pump Test

Test	Test Start Date	Depth to LNAPL (ft)	Depth to Groundwater (ft)	LNAPL Thickness (ft)
Initial Skimmer Pump Test	8/10/95	6.77	7.25	0.48
Bioslurper Pump Test	8/12/95	6.89	6.97	0.08
Drawdown Pump Test	8/16/95	6.92	6.94	0.02

Table 16. Pump Test Results at Site SS010, Robins AFB, GA

Recovery Rate (gal/day)	Initial Skimmer Pump Test		Bioslurper Pump Test		Drawdown Pump Test	
	LNAPL	Groundwater	LNAPL	Groundwater	LNAPL	Groundwater
Day 1	1.6	870	5.0	1,510	0.27	1,790
Day 2	1.1	890	2.3	1,500	0.55	1,820
Day 3	NA	NA	3.5	1,390	NA	NA
Day 4	NA	NA	1.1	1,380	NA	NA
Average	1.4	880	3.2	1,460	0.36	1,800
Total Recovered (gal)	2.5	1,550	11.5	5,220	0.50	2,480

NA = Not applicable.

extraction rate of 880 gallons/day (Table 16). Results of LNAPL recovery versus time are shown in Figure 13.

3.3.3.2 Bioslurper Pump Test Results

LNAPL recovery rates increased during the bioslurper pump test (Figure 13). The increase in recovery rate indicates that LNAPL was mobilized to the extraction well under vacuum-enhanced conditions. A total of 11.5 gallons of LNAPL and 5,220 gallons of groundwater were extracted during the bioslurper pump test, with average recovery rates of 3.2 gallons/day for LNAPL and 1,460 gallons/day for groundwater (Table 16). The LNAPL recovery rate versus time is shown in Figure 14. The vacuum-exerted wellhead pressure on monitoring well LF-1-3 was kept relatively constant throughout the bioslurper pump test at approximately 16 inches of mercury.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Oxygen concentrations increased slightly at all monitoring points where a soil gas sample could be collected (Table 17). Given the low permeability of the soil, a longer time period than the length of this test may be necessary to fully

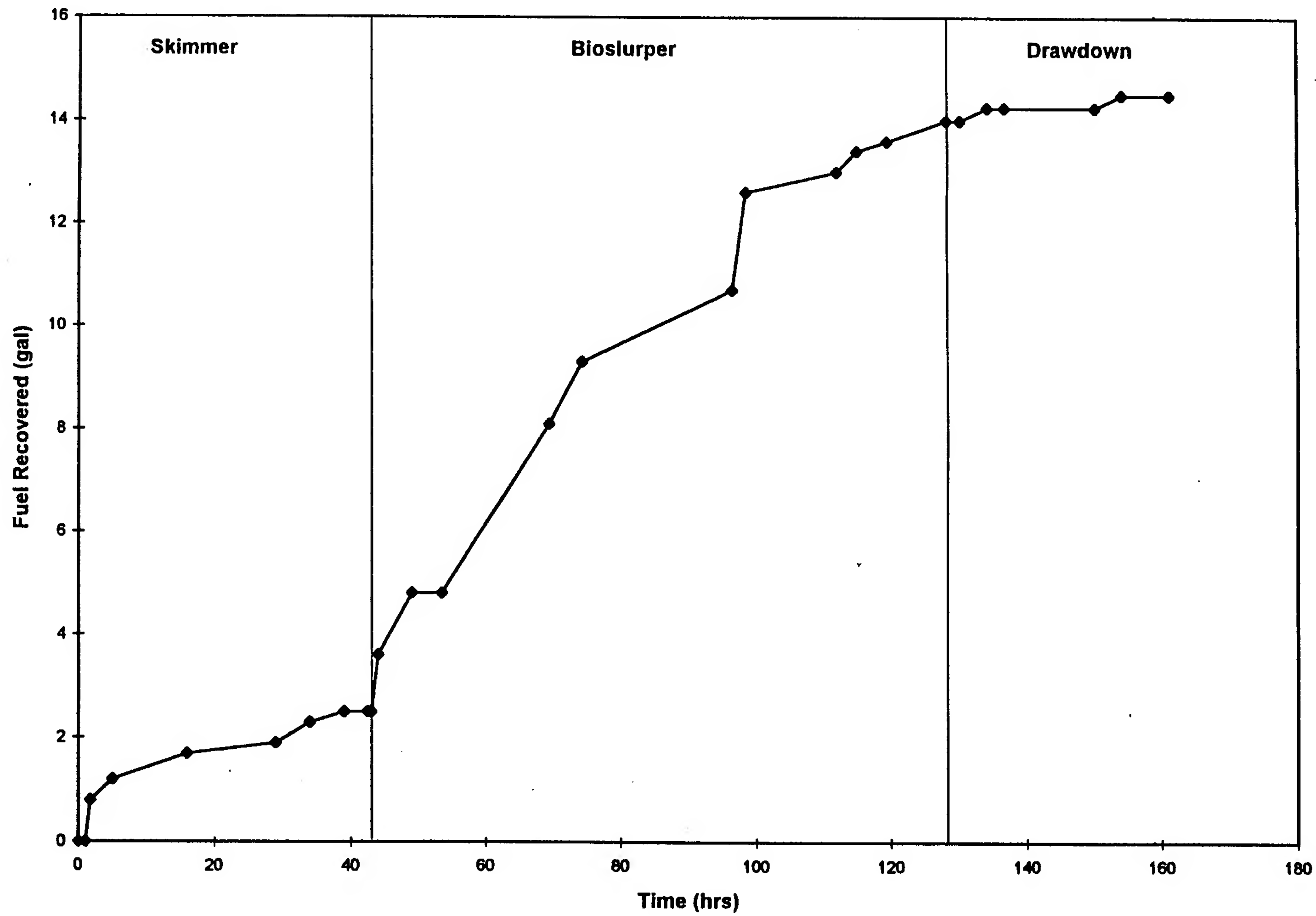

Figure 13. LNAPL Recovery Versus Time During Each Pump Test at Site SS010

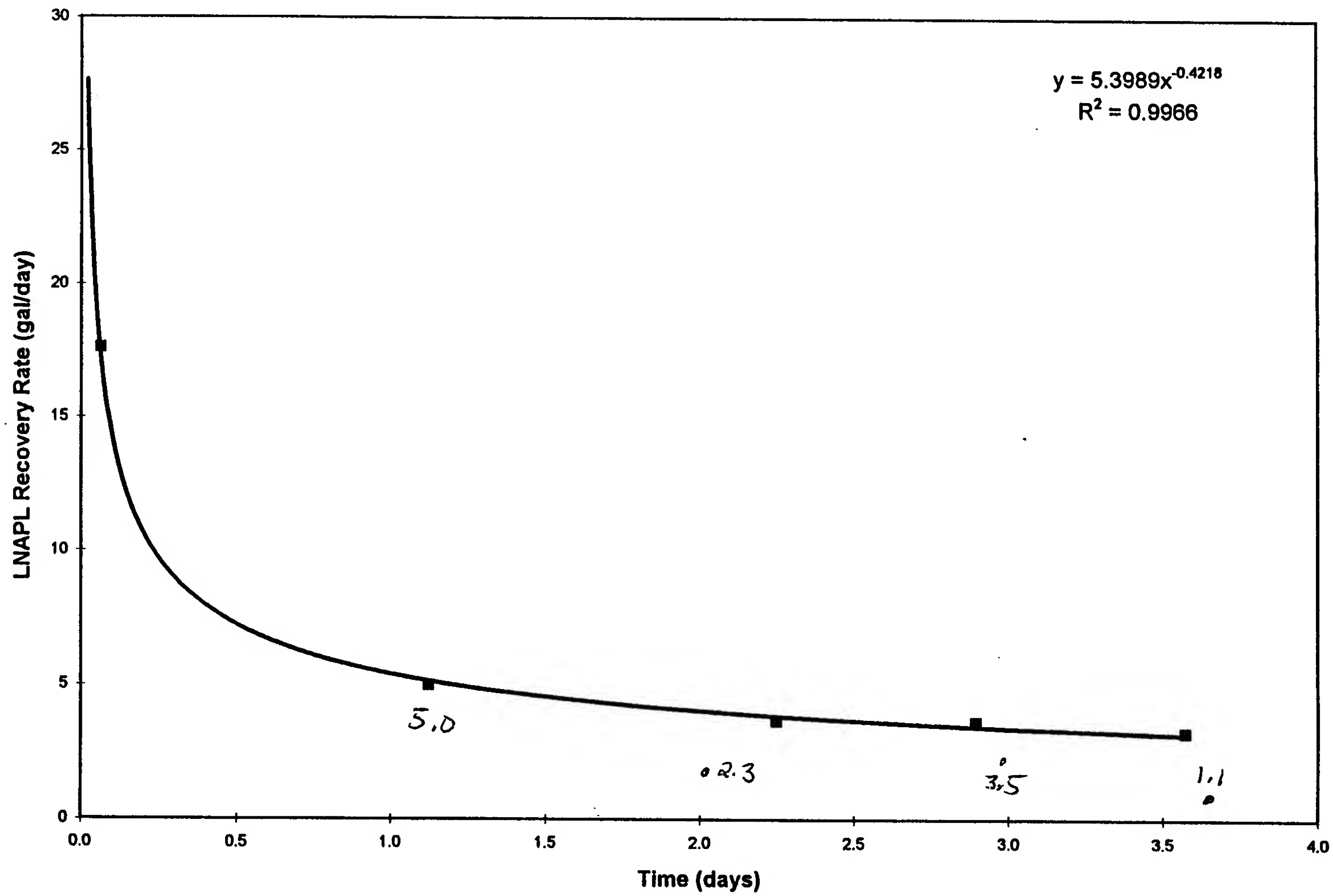

Figure 14. LNAPL Recovery Rate Versus Time During the Bioslurper Pump Test at Site SS010

Table 17. Oxygen Concentrations During the Bioslurper Pump Test at Site SS010, Robins AFB, GA

Monitoring Point	Oxygen Concentrations (%) Versus Time (minutes)				
	0	4.5	26	48	80
R2-MPA-2.0′	19.5	19.6	19.5	19.8	19.8
R2-MPA-4.0′	5.0	5.2	5.5	5.7	5.7
R2-MPA-6.0′	NM	NM	NM	NM	NM
R2-MPB-2.0′	19.2	19.5	19.5	19.7	19.8
R2-MPB-4.0′	9.2	9.3	9.5	9.8	9.9
R2-MPB-6.0′	NM	NM	NM	NM	NM
R2-MPC-2.0′	15.2	15.4	15.7	15.9	16.0
R2-MPC-4.0′	9.3	9.6	9.6	9.9	9.9
R2-MPC-6.0′	NM	NM	NM	NM	NM

NM Not measured. Excess soil moisture prohibited collection of soil gas samples.

oxygenate the soils. However, based on these results, it is likely that soils will become oxygenated over time. These results correlate with radius of influence results from the soil gas permeability test.

3.3.3.3 Drawdown Pump Test

Totals of 0.50 gallon of LNAPL and 2,480 gallons of groundwater were recovered during the drawdown pump test, with average recovery rates of 0.36 gallon/day for LNAPL and 1,800 gallons/day for groundwater (Table 16). These results demonstrate that operation of the bioslurper system in the drawdown mode was not as effective a means of free-product recovery as the bioslurper system at this site.

3.3.4 Emulsion Control and Extracted Groundwater, LNAPL, and Off-Gas Analyses

During the skimmer, bioslurper, and drawdown pump tests, the emulsion control system minimized the formation of the solid fuel/water emulsion; however, the liquid fuel/water emulsion was not affected. Consequently, contaminant concentrations were not significantly reduced by the emulsion control system. Treatment through activated carbon resulted in BTEX and TPH concentrations reduced to below detection limits (Table 18).

Table 18. BTEX and TPH Concentrations in Extracted Groundwater During the Bioslurper Pump Test at Site SS010, Robins AFB, GA

Parameter	Concentration (mg/L)				
	TPH	Benzene	Toluene	Ethylbenzene	Total Xylenes
R2-H2O-1	46	0.19	0.052	0.39	0.58
R2-H2O-2	36	0.099	0.047	<0.00050	0.14
R2-H2O-3	22	0.36	0.30	0.092	0.57
R2-H2O-4	<0.50	<0.00050	<0.00050	<0.00050	<0.00050
R2-OutH2O-1	<0.50	<0.0010	<0.0010	<0.0010	<0.0010
R2-OutH20-2	<0.50	<0.0010	<0.0010	<0.0010	<0.0010

Off-gas samples from the bioslurper system also were collected during the bioslurper pump test. The results from the off-gas analyses are presented in Table 19. Given a vapor discharge rate of 5.5 scfm and using an average concentration of 680 ppmv TPH[1], approximately 2.2 lb/day of TPH was emitted to the air during the bioslurper pump test. Benzene emissions were approximately 0.021 lb/day.

The composition of LNAPL is shown in Tables 20 and 21 in terms of BTEX concentrations and distribution of C-range compounds, respectively. The distribution of C-range compounds is shown graphically in Figure 15.

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[1] This concentration was considered to be more representative of actual long-term operating conditions.

Table 19. BTEX and TPH Concentrations in Off-Gas During the Bioslurper Pump Test at Site SS010, Robins AFB, GA

Parameter	Concentration (ppmv)	
	R2-Stack-1	R2-Stack-2
TPH	60,000	680
Benzene	830	13
Toluene	890	21
Ethylbenzene	200	6.7
Total Xylenes	750	29

Table 20. BTEX Concentrations in LNAPL from Site SS010, Robins AFB, GA

Compound	Concentration (mg/kg)
Benzene	<720
Toluene	1,400
Ethylbenzene	2,200
Total Xylenes	18,000

Table 21. C-Range Compounds in LNAPL from Site SS010, Robins AFB, GA

C-Range Compound	Percentage of Total
<C9	38.7
C10	19.3
C11	15.6
C12	11.1
C13	8.3
C14	3.9
C15	1.9
C16	0.63
>C17	0.45

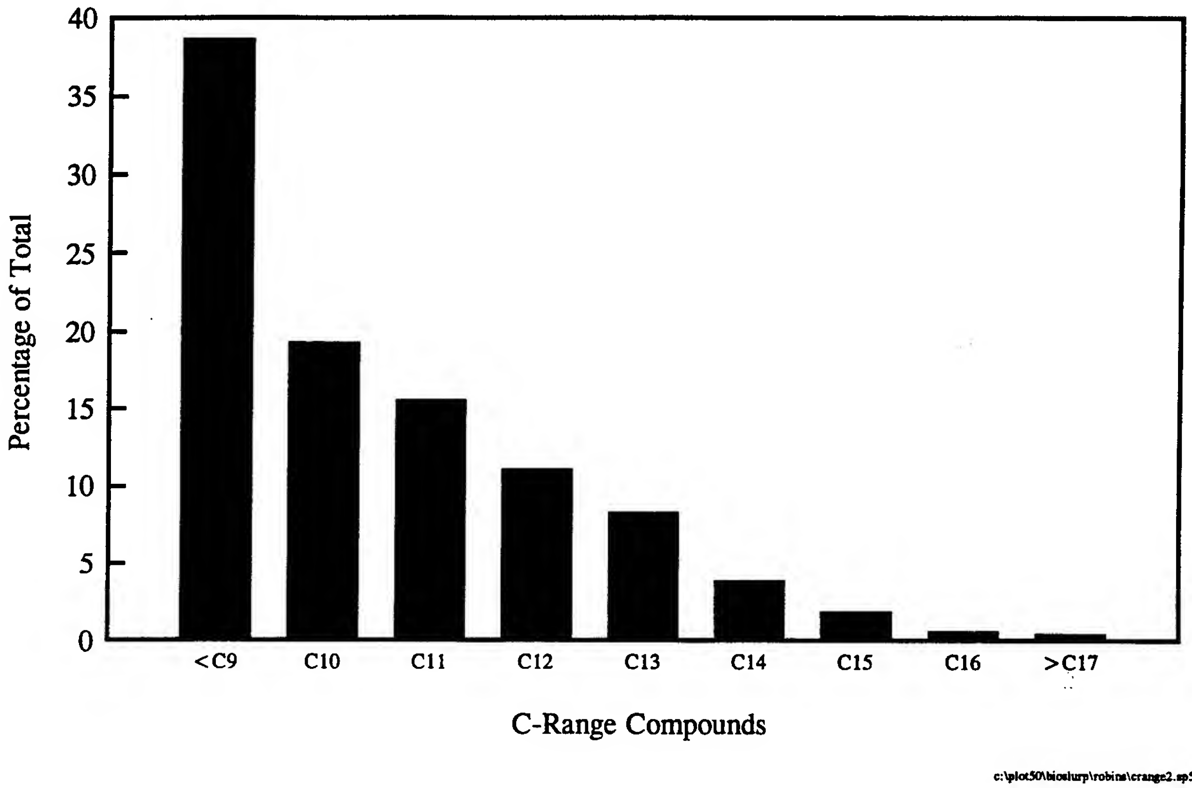


Figure 15. **Distribution of C-Range Compounds in Extracted LNAPL at Site SS010, Robins AFB, GA**

3.3.5 Bioventing Analyses

3.3.5.1 Soil Gas Permeability and Radius of Influence

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the extraction well. The radius of influence is then defined as the distance from the extraction well where 0.1 inch of H_2O can be measured. Based on this definition, the radius of influence at this site is approximately 76 ft (Figure 16).

3.3.5.2 In Situ Respiration Test Results

Results from the in situ respiration test are presented in Table 22. Oxygen depletion was relatively rapid, with oxygen utilization rates ranging from 0.20 to 0.27% O_2/hr. Biodegradation rates ranged from 3.3 to 4.5 mg/kg-day. The helium concentration was steady, indicating that leakage and diffusion were insignificant.

Table 22. In Situ Respiration Test Results at Site SS010, Robins AFB, GA

Monitoring Point	Oxygen Utilization Rate (%/hr)	Biodegradation Rate (mg/kg-day)
R2-MPA-4.0′	0.27	4.3
R2-MPB-4.0′	0.20	3.2
R2-MPC-4.0′	0.27	4.3

3.4 Discussion

Free-product recovery was poor at this site during all pump tests. The maximum recovery rate was achieved during the bioslurper pump test; however, the average recovery rate was 3.2 gallons/day compared to an average groundwater extraction rate of 1,500 gallons/day. Free-product recovery may be limited due to the site hydrogeology, to the condition that only small quantities of free product may be present.

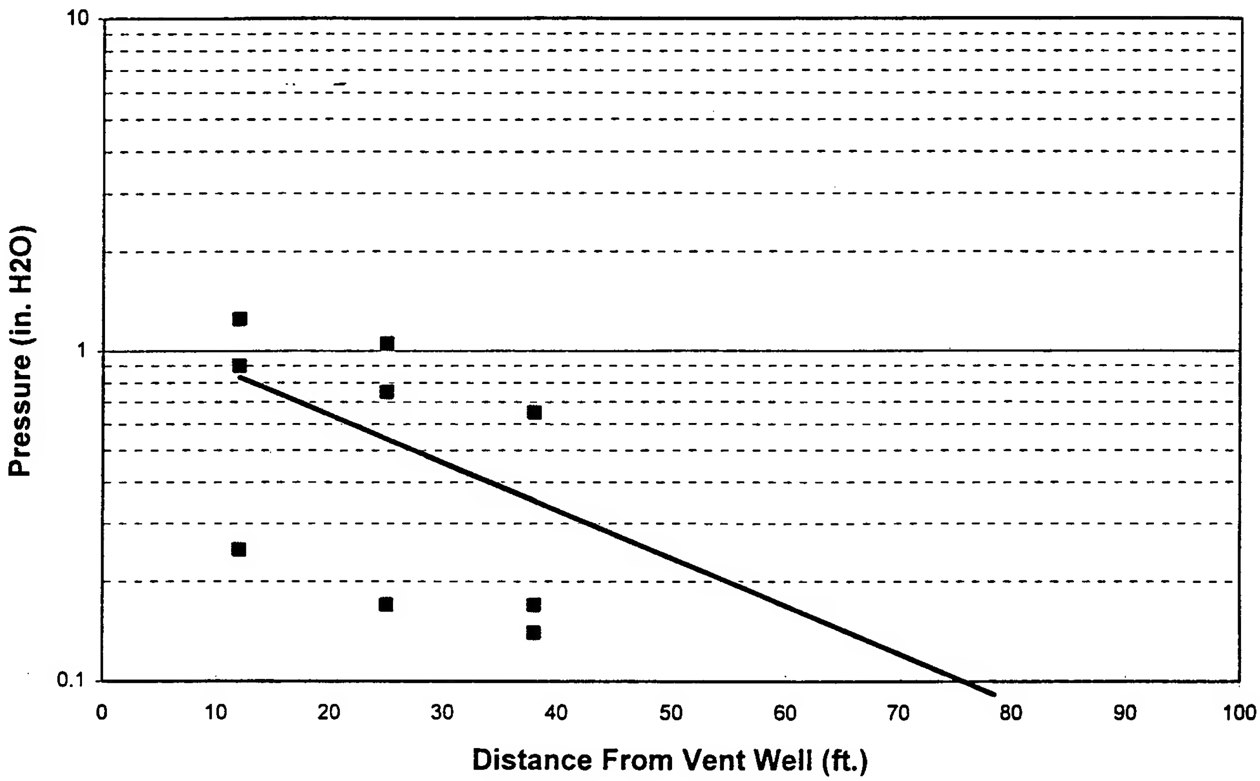


Figure 16. **Soil Gas Pressure Change as a Function of Distance During the Soil Gas Permeability Test at Site SS010**

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Oxygen concentrations increased slightly at all monitoring points where a soil gas sample could be collected. As at Site UST 70/72, given the low permeability of the soil, a longer time period than the length of this test may be necessary to fully oxygenate the soils. However, based on these results, it is likely that soils will become oxygenated over time.

Implementation of bioslurping at Site SS010 does not appear to be a feasible option for free-product recovery due to the low recovery rate versus the high groundwater extraction rate. Given that free-product recovery was poor during all pump tests, the quantity of free product present may be low. Therefore, intrinsic bioremediation may be a more appropriate option for this site.

4.0 REFERENCES

Battelle. 1995. *Test Plan and Technical Protocol for Bioslurping*, Report prepared by Battelle Columbus Operations for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Rev. 2), Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering Sciences, Inc. for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

APPENDIX A

SITE-SPECIFIC TEST PLAN FOR BIOSLURPER FIELD ACTIVITIES AT ROBINS AFB, GEORGIA

SITE-SPECIFIC TEST PLAN FOR BIOSLURPER TESTING AT ROBINS AIR FORCE BASE, GEORGIA (A002)
CONTRACT NO. F41624-94-C-8012

FINAL

to

U.S. Air Force Center for Environmental Excellence
Technology Transfer Division
(AFCEE/ERT)
8001 Arnold Drive
Building 642
Brooks AFB, TX 78235

June 5, 1995

by

Battelle
505 King Avenue
Columbus, OH 43201

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FINAL SITE-SPECIFIC TEST PLAN FOR BIOSLURPER FIELD ACTIVITIES AT ROBINS AIR FORCE BASE, GEORGIA

June 5, 1995

to

U.S. Air Force Center for Environmental Excellence
Technology Transfer Division
AFCEE/ERT
Brooks AFB, TX

1.0 INTRODUCTION

The Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division is conducting a nationwide application of an innovative technology for free-product recovery and soil bioremediation. The technology being tested is vacuum-enhanced free-product recovery with bioremediation (bioslurping). The field test and evaluation are intended to demonstrate the initial feasibility of bioslurping by measuring system performance in the field. The Bioslurper Initiative has been designed to evaluate the effectiveness of bioslurping as a light, non-aqueous phase liquid (LNAPL) recovery technology relative to conventional gravity-driven recovery technologies. System performance parameters, mainly free-product recovery, will be determined at numerous sites. Field testing will be performed at many sites to determine the effects of different organic contaminant types and concentrations and different geological conditions on bioslurping effectiveness.

Plans for the field test activities are presented in two documents. The first is the overall Test Plan and Technical Protocol for the entire program, titled *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). The overall plan is supplemented by plans specific to each test site. The concise site-specific plans communicate vapor and aqueous discharge rates to ensure compliance with regulatory requirements specific to the base.

The overall Test Plan and Technical Protocol was developed as a generic plan for the Bioslurper Initiative to improve the accuracy and efficiency of Test Plan preparation. The field program requires installation and operation of the bioslurping system supported by a wide variety of site characterization, performance monitoring, and chemical analysis activities. The basic methods to be applied from site to site do not change. Preparation and review of the overall plan allows efficient documentation and review of the basic approach to the test program. Peer and regulatory review were performed for the overall plan to ensure the credibility of the overall program.

This letter report is the site-specific plan for application of bioslurping at Robins Air Force Base (AFB), Georgia. It was prepared based on site-specific information received by Battelle from Robins AFB and other pertinent site-specific information to support the generic test plan.

Site-specific information for Robins AFB included data for the two pilot test locations: the JP-4 Spill Site (Zone 4-JP-4 Fuel Spill Site SS010, referred to as Site SS010 in text) and the Underground Storage Tank (UST) #70 and #72 Site. An initial review of the data for Site SS010 indicates that Well #LF1-3 appears to be the best candidate for the bioslurper field test. If Well #LF1-3 is found unsuitable for testing, Well #RI-4-JP-6 is a viable alternative. At the UST #70 and #72 Site, the well

that appears to be the best candidate for bioslurper testing is Well #EA-2. If Well #EA-2 is found to be unsuitable for testing or site logistics prevent its use, then Well #EA-1 could be used as an alternative extraction well for the bioslurper pilot test. Also, in order to supplement existing site characterization data and the bioslurper testing, AFCEE/ERT has mobilized a cone penetrometer equipped with an innovative laser induced fluorescence sensor (CPT-LIF). The laser induce fluorescence sensor provides useful information on fuel contamination distribution for both Robins AFB sites based on the fluorescence response to polycyclic aromatic fuel constituents (i.e. naphthalene). CPT-LIF data is presented in Appendix A for locations near both sites at Robins AFB.

2.0 SITE DESCRIPTION

2.1 Site SS010

The site description of Site SS010 has been adapted from the *Installation Restoration Program RCRA Facility Investigation Report for Robins AFB* prepared by CH2M Hill Southeast, Inc. (August 1989). This document is referred to as IRP 1989 in the text. The JP-4 fuel storage tanks in Zone 4 are supplied by a 4-inch-diameter steel pipe running from the Standard Transmission Corporation Tank Farm located to the north of Robins AFB. Two major fuel spills have occurred in Zone 4 during the past 30 years. The first fuel spill occurred in the mid-1960s when a leak in the 4-inch supply line was discovered. An undetermined amount of JP-4 jet fuel was released in the area north of the petroleum, oil, and lubricants (POL) bulk storage area in the vicinity of Landfill No.1. The pipeline was repaired; however, none of the JP-4 jet fuel was recovered. The second spill occurred in the early 1970s. An estimated 60,000 gallons of JP-4 jet fuel was released to the surface when a POL storage tank overflowed. During the overflow, the containment dike valve had been left open and the fuel was able to flow into drainage ditches that lead to Horse Creek. A small, undetermined volume of the JP-4 jet fuel was recovered during cleanup operations. However, recent site characterization studies have shown that a large LNAPL plume is still present at Site SS010.

Figure 1 is a site map that depicts Site SS010, Robins AFB. This figure appeared in the IRP 1989 report. Table 1 provides data for the free-product thickness measurements made on February 5 and 6 and April 4 and 8, 1991, by base personnel. A generalized cross section extending north-south across Site SS010 is also presented in Appendix B. From these data, the wells that are most likely to yield significant amounts of free product have been identified. Well #LF1-3 had the largest fuel thickness during the February 5, 1991, measurement and has shown the greatest amount of free-product recovery throughout the measurement period. Soil-gas concentrations of total petroleum hydrocarbon (TPH) and benzene in 1992 were approximately 55,000 ppm and 270 ppm, respectively. Groundwater near the site ranges from 6.75 to 8.25 ft. Site characterization will start with Site SS010 and will focus on Well #LF1-3. If preliminary site characterization indicates that Site SS010 is unsuitable, or if site logistics prevent the use of wells in that area, the AFCEE/ERT and Base Point of Contact (POC) will be notified immediately to discuss alternative sites where the bioslurper pilot demonstration could be conducted.

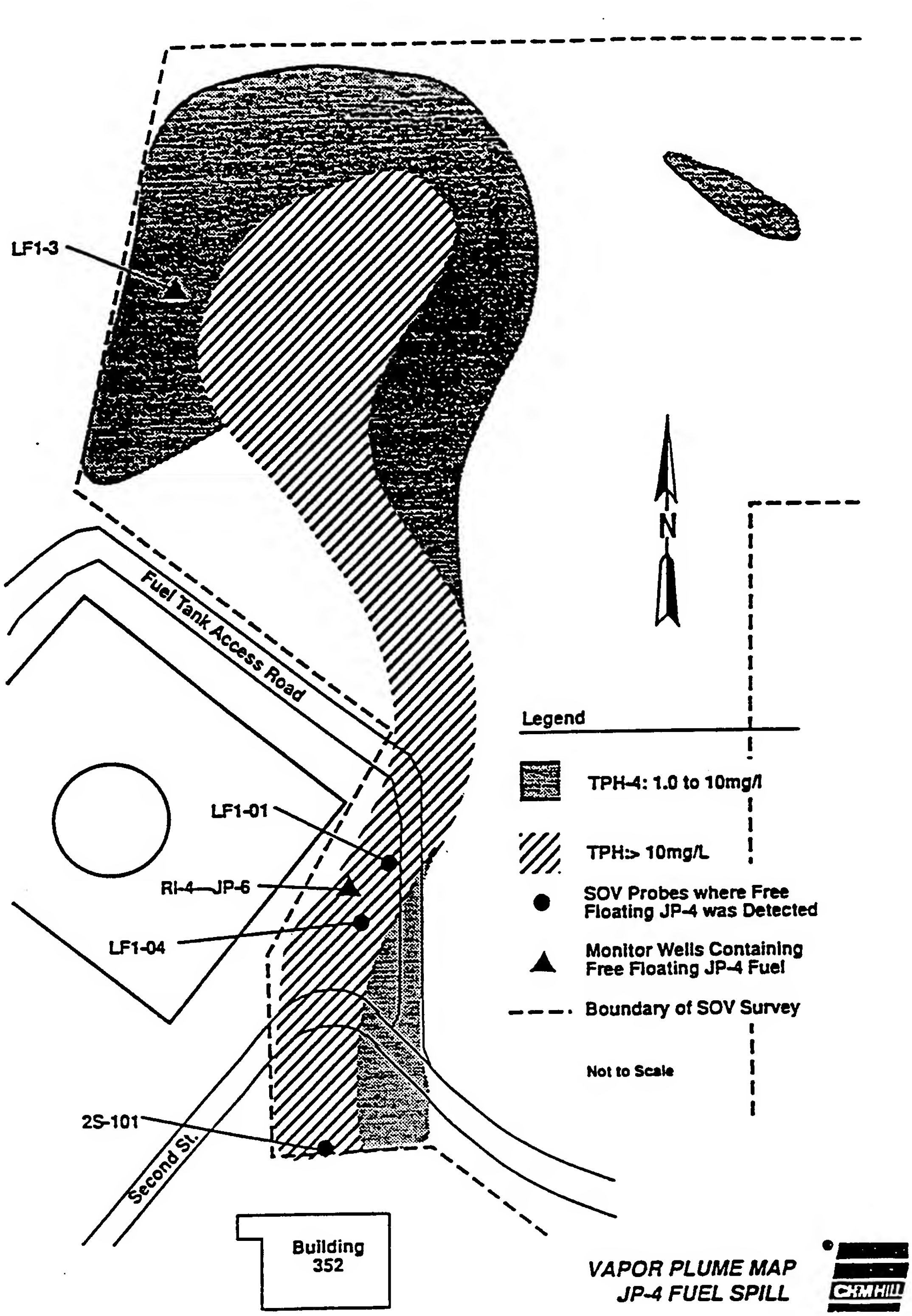


Figure 1. Schematic Diagram Showing Areas of Interest for Bioslurper Testing at Site SS010, Robins AFB, GA

Table 1. Free Product Thickness Measurements for Site SS010

Well ID	Date	LNAPL Thickness (ft)
LF1-3	February 5, 1991	1.9
	April 4, 1991	1.2
RI-4-JP-6	February 6, 1991	0.9
	April 8, 1991	0.5

2.2 UST #70 and #72 Site

The site description of the UST #70 and #72 Site has been adapted from the *Contamination Assessment Report for the Underground Storage Tank Systems at UST Sites #70 and #72 for Robins AFB* prepared by EA Engineering, Science, and Technology (November 1994). This document is referred to as CAR 1994 in the text. The UST #70 and #72 Site is in the 19th and 912th Air Refueling Wing area located in the northeastern quadrant of Robins AFB. The UST #70 and #72 Site serves as large aircraft refueling/defueling hydrant system, which provides ground support to the Air Refueling Wings operating at Robins AFB.

Figure 2 shows the location of monitoring wells and the estimated extent of free product within the UST #70 and #72 Site. Free-product recovery data, geologic cross sections, and boring logs for the wells within the UST #70 and #72 Site are located in Appendix C. The aircraft refueling/defueling hydrant system at UST #70 consists of a small storage building, a pumphouse/control room, six 50,000-gal steel USTs currently containing JP-8, a 2,000-gal steel UST containing waste JP-8, a 400-gal UST containing water, and approximately 5,200 ft of 4- to 6-inch-diameter steel fueling/defueling lines that supply six hydrants located on the adjacent parking apron. UST #72 is identical to UST #70, in that it has the same tankage and piping configuration. It is located directly north of UST #70.

The #70 and #72 USTs were installed in 1958 and have been used continuously since that time. The two systems originally stored JP-4 jet fuel and were not converted over to JP-8 jet fuel until June 1994. According to the Fuels Maintenance Branch staff at Robins AFB, large nondocumented releases of JP-4 jet fuel have occurred at UST#70 several times. The releases were controlled by the Base Fire Department, which hosed the spilled JP-4 jet fuel with water. The resultant contamination of the clean up occurred off the parking lot aprons and into the soils and storm drains adjacent to the site.

Analytical data taken during the CAR 1994 report listed groundwater concentration of benzene ranged from approximately <0.0010 to 4.2 mg/L, and the TPH concentration in soils ranged from approximately <270 to 5,700 mg/kg. Groundwater at the site is found at 7 ft bgs. From the initial review of data presented in the CAR 1994 report it appears that Wells #EA-2 and #EA-1 are the best candidates for the short-term bioslurper test. These wells had persistent measurements of LNAPL thickness during the CAR 1994 report.

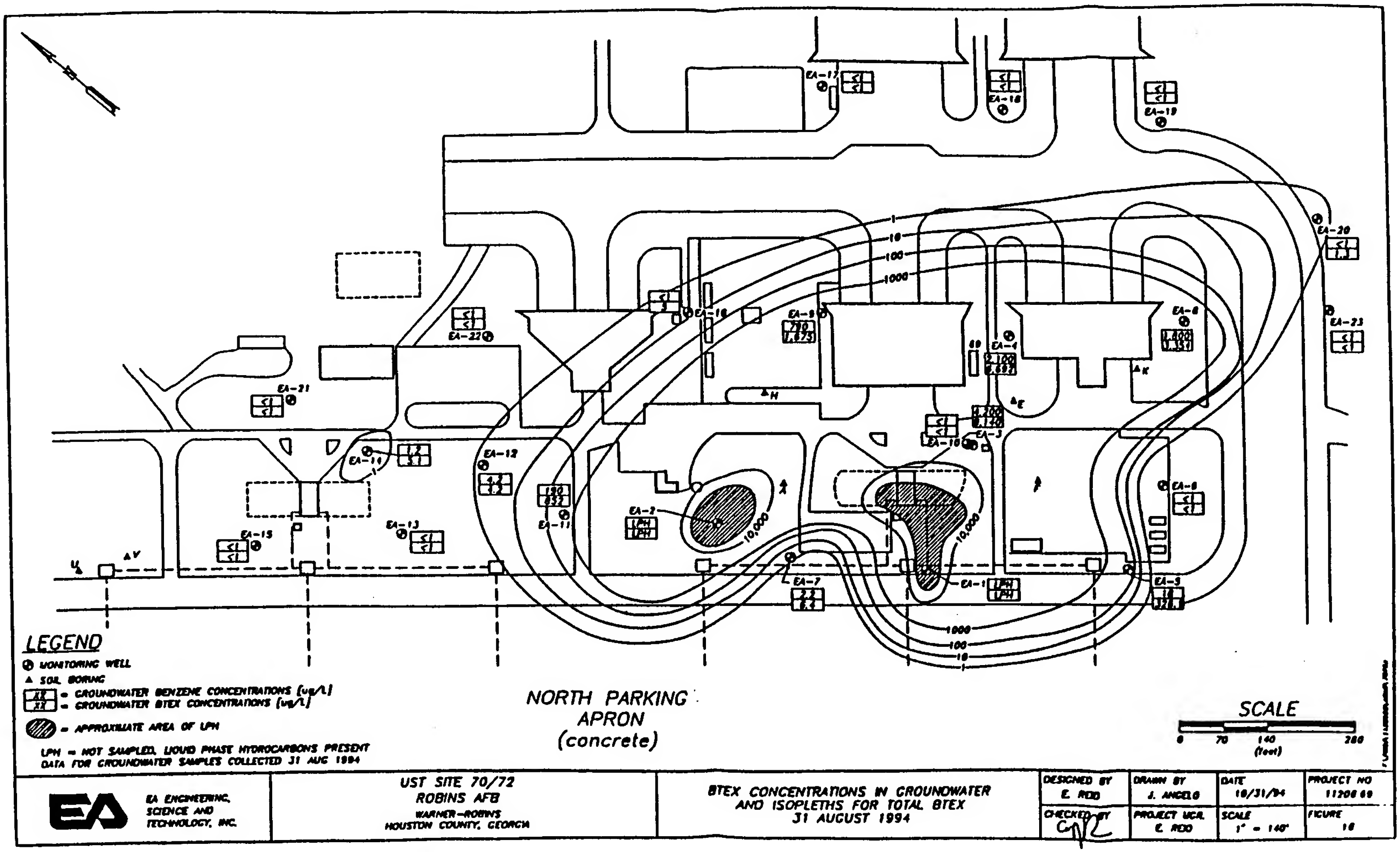


Figure 2. Schematic Diagram Showing Location of Monitoring Wells at UST #70 and #72 Site, Robins AFB, GA

3.0 PROJECT ACTIVITIES

The following field activities are planned for the bioslurper pilot test at Robins AFB. Additional details about the activities are presented in the *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). As appropriate, specific sections in the generic Test Plan and Technical Protocol are referenced. Table 2 shows the schedule of activities for the Bioslurper Initiative at Robins AFB.

3.1 Mobilization to the Site

After the site-specific Test Plan is approved, Battelle staff will mobilize equipment. Some of the equipment will be shipped via air express to Robins AFB prior to staff arrival. The Base POC will have been asked in advance to find a suitable holding facility to receive the bioslurper pilot test equipment so that it will be easily accessible to the Battelle staff when they arrive with the remainder of the equipment. The exact mobilization date will be confirmed with the Base POC as far in advance of fieldwork as is possible. The Battelle POC will provide the Base POC with information on each Battelle employee who will be on site. Battelle personnel will be mobilized to the site after it has been confirmed that the shipped equipment has been received by Robins AFB.

Table 2. Schedule of Bioslurper Test Activities

Pilot Test Activity	Schedule
Mobilization	day 1-2
Site Characterization	day 2-3
Baildown Tests and Product/Groundwater Interface Monitoring	
Soil-Gas Survey (limited)	
Slug Tests	
Monitoring Point Installation (3 MPs)	
Soil Sampling (TPH, BTEX, physical characteristics)	
System Installation	day 2-3
Test Startup	day 3
Skimmer Test (2 days)	day 3-4
Bioslurper Vacuum Extraction (4 days)	day 6-9
Soil-Gas Permeability Testing	day 6
Skimmer Test (continued)	day 10
In Situ Respiration Test — air/helium injection	day 10
In Situ Respiration Test — monitoring	day 11-16
Drawdown Pump Test (2 days)	day 11-12
Demobilization/Mobilization	day 13-14

3.2 Site Characterization Tests

3.2.1 Baildown Tests

The baildown test is the primary test for selection of the bioslurper test well. Baildown tests will be performed at wells that contain measurable free product to estimate the recovery potential at those particular wells. At the Site SS010, baildown tests will be performed on Wells #LF1-3 and #RI-4-JP-6. For the UST #70 and #72 Site, baildown tests will be performed on Wells #EA-1 and #EA-2. Detailed procedures for the baildown tests are provided in Section 5.6 of the Test Plan and Technical Protocol.

3.2.2 Soil-Gas Survey (Limited)

If existing monitoring points are suitably located, no new monitoring will be installed. If installation of monitoring points is required, a small-scale soil-gas survey will be conducted to identify the best location for installation of the bioslurping system soil gas monitoring points. The soil-gas survey will be conducted in areas where historical site data indicate the highest contamination levels of floating LNAPL. These areas will be surveyed to select the locations for installation of soil-gas monitoring points. Soil-gas monitoring points will be located in areas that exhibit the following soil-gas characteristics:

1. Relatively high TPH concentrations (10,000 ppm or greater).

2. Relatively low oxygen concentrations (between 0% and 5%).

3. Relatively high carbon dioxide concentrations (depending on soil type, between 2% and 10% or greater).

To obtain further information about the soil-gas survey, consult Section 5.2 of the Test Plan and Technical Protocol.

3.2.3 Slug Tests

Slug tests will be performed to determine the characteristics of the aquifer where the candidate bioslurper test well is located. Slug tests will be performed using one or more in situ pressure transducers and data loggers to track pressure (water-level) changes and a polyvinyl chloride (PVC) capsule (slug) to introduce a rapid level change. Slug tests will be performed on wells that do not have any measurable free product. Using the data collected during the slug test, the aquifer characteristics at Site SS010 and the UST #70 and #72 Site will be compared with those at other bioslurper test sites. Additional information about the slug test methods can be found in Section 5.7 of the Test Plan and Technical Protocol.

3.2.4 Monitoring Point Installations

Monitoring points will be installed to determine the radius of influence of the bioslurper system in the vadose zone. A general arrangement of the bioslurping well and monitoring points is shown in Figure 3.

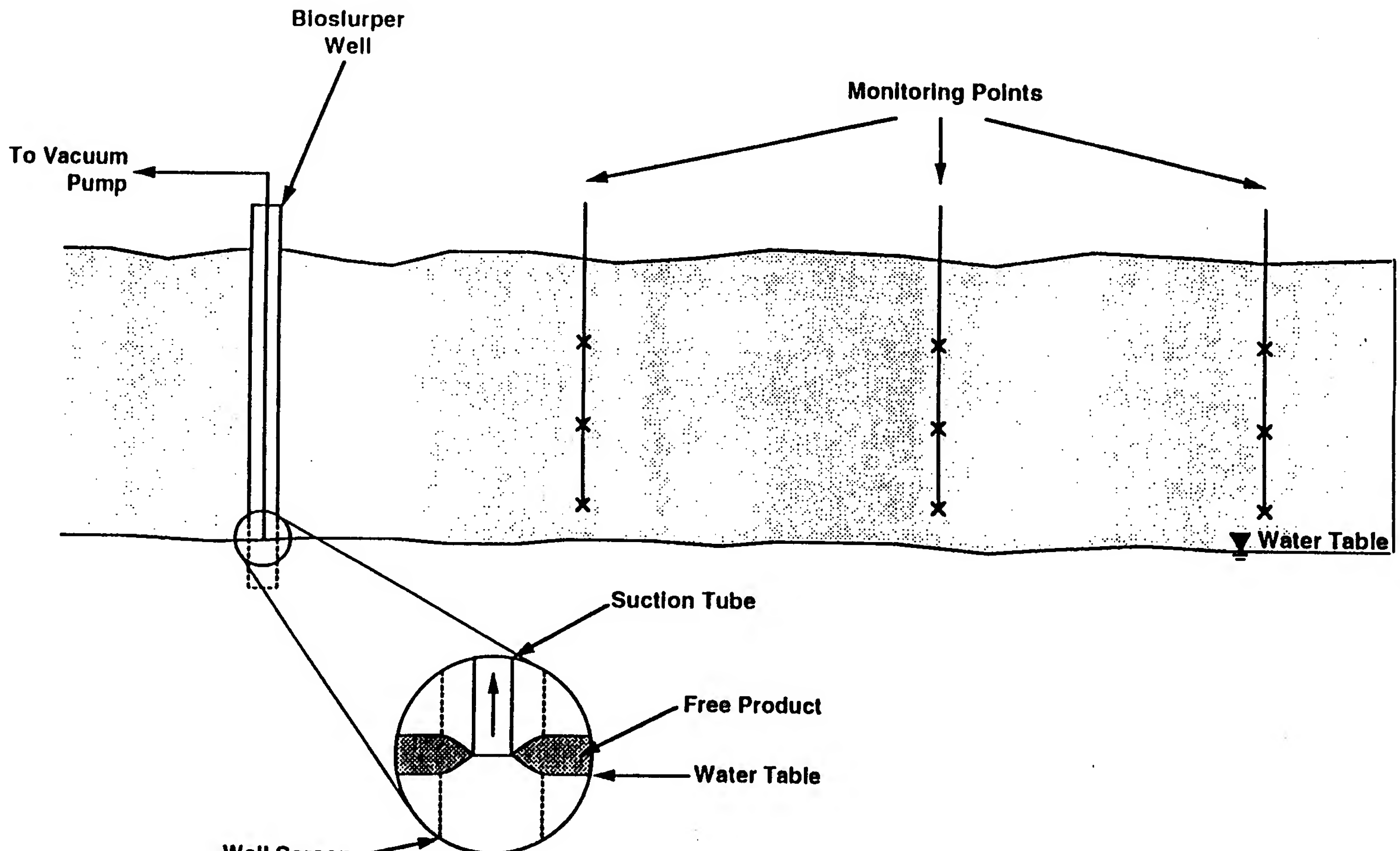


Figure 3. General Bioslurper Well and Monitoring Point Arrangement

Upon conclusion of the initial soil-gas survey and baildown tests, at least three soil-gas monitoring points will be installed at each site to measure soil-gas changes that occur during bioslurper operation. A digging clearance or permit will be obtained by the Base POC before Battelle staff arrive at the base. These monitoring points will be located in highly contaminated soils within the free-phase plumes and will be positioned to allow detailed monitoring of the in situ changes in soil-gas composition caused by the bioslurper system. A schematic diagram of a typical soil-gas monitoring point is shown in Figure 4. Additional information on monitoring point installation can be found in Section 4.2.1 of the Test Plan and Technical Protocol.

3.2.5 Soil Sampling

Soil samples will be collected to determine the physical and chemical composition of the soil. Soil samples will be collected from the boreholes advanced for monitoring point installation at two or three locations. Generally, samples will be collected from the capillary fringe over the free product.

Soil samples from each boring will be analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX); bulk density; moisture content; particle-size distribution; porosity; and TPH. Section 5.5.1 of the Test Plan and Technical Protocol will be consulted for information on the field measurements and sample collection procedures for soil sampling.

3.3 Bioslurper System Installation and Operation

As stated previously, Wells #LFI-3 and #EA-2 most likely will be used for the bioslurper test demonstrations at Site SS010 and the UST #70 and #72 Site, respectively. Once the wells to be used have been selected, the bioslurper and support equipment will be installed.

3.3.1 System Setup

Upon completion of the site characterization activities and the bioslurper system assembly, the LNAPL recovery tests will be initiated. Figure 5 is a flow diagram of the bioslurper process. Figure 6 is a schematic diagram of a typical bioslurper extraction wellhead and extraction tube that will be installed on existing extraction wells at the two Robins AFB test sites.

Before the LNAPL recovery tests are initiated, all relevant baseline field data will be collected and recorded. These data will include soil-gas concentrations, initial soil-gas pressures, depth to groundwater, and LNAPL thickness. All the atmospheric conditions (e.g., temperature, humidity, barometric pressure) also will be recorded. All emergency equipment (i.e., emergency shutoff switches and fire extinguishers) will be installed and checked for proper operation at this time.

A clear, level area near the well selected for the bioslurper test installation will be identified for the 20' X 10' flatbed trailer that holds the equipment required for the bioslurper system operation. For more information on bioslurper system installation, consult Section 6.0 of the Test Plan and Technical Protocol.

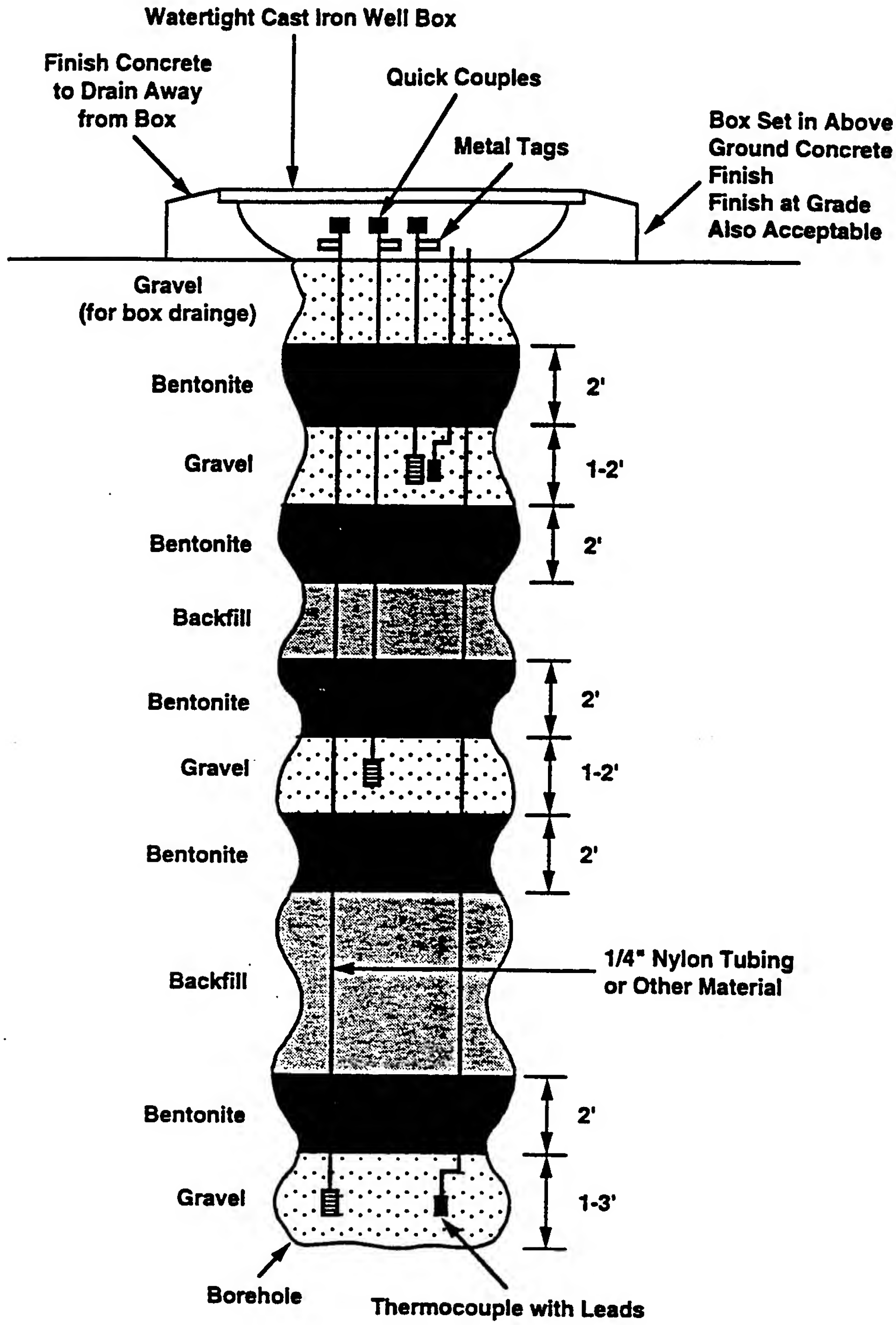


Figure 4. Schematic Diagram of a Typical Soil-Gas Monitoring Point

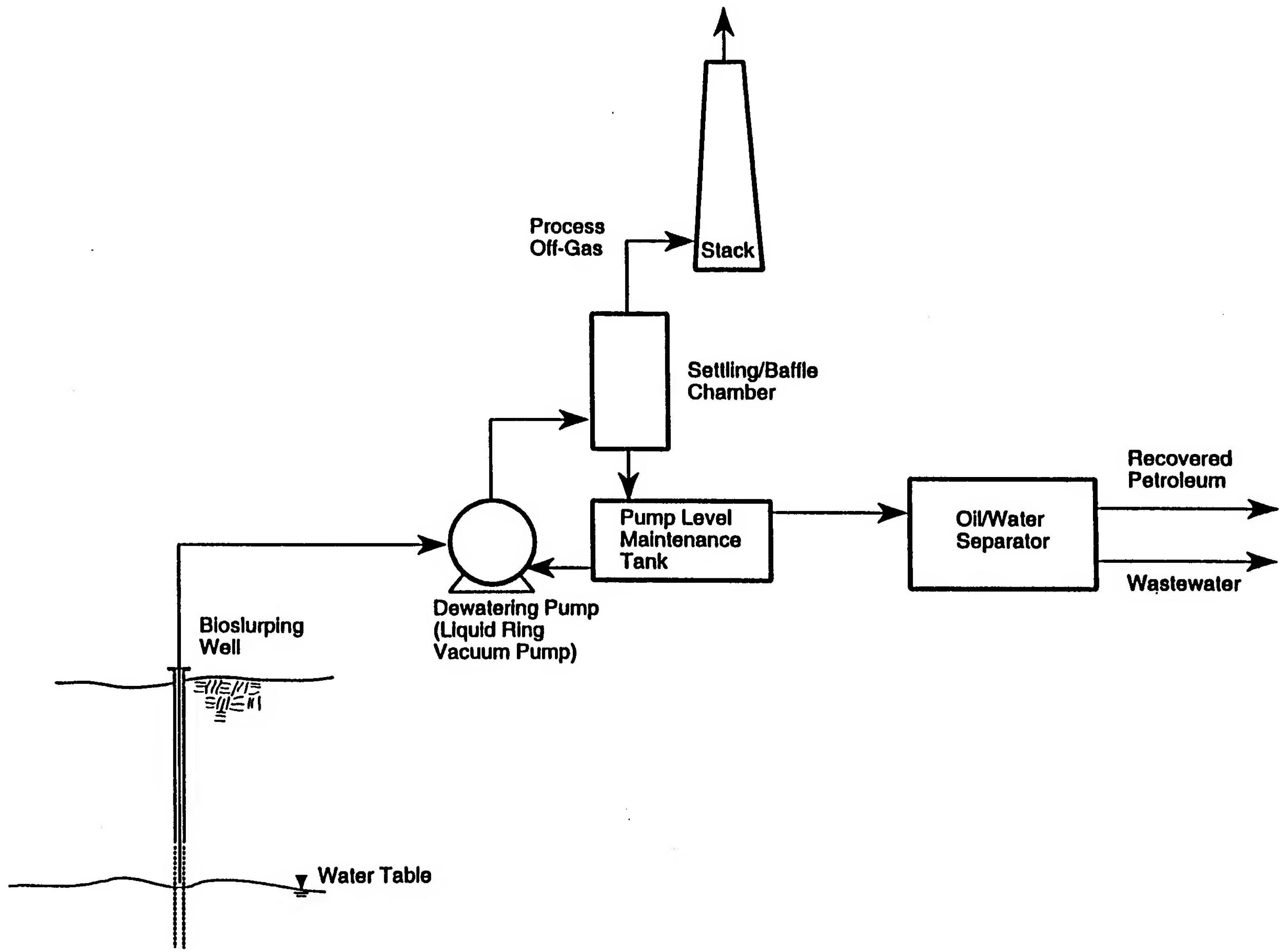


Figure 5. Bioslurper Process Flow

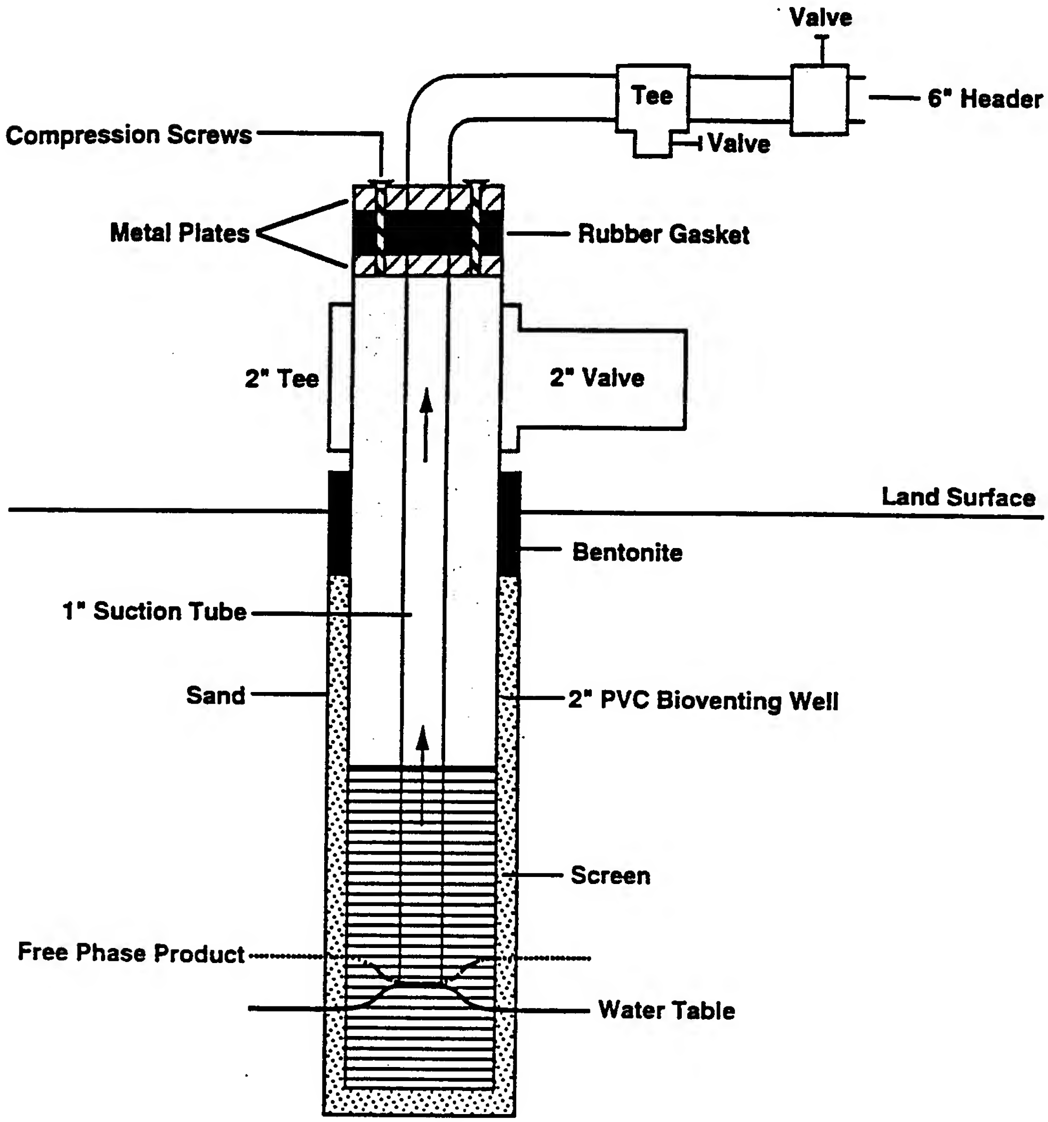


Figure 6. Schematic Diagram of a Typical Bioslurper Well

3.3.2 System Shakedown

A brief startup test will be conducted to ensure that the system is constructed properly and operates safely. All system components will be checked for problems and/or malfunctions. A checklist will be provided to document the system shakedown.

3.3.3 System Startup and Test Operations

After installation is complete and the bioslurper system is confirmed to be operating properly, the LNAPL recovery tests will be started. The Bioslurper Initiative has been designed to evaluate the effectiveness of bioslurping as an LNAPL recovery technology relative to conventional gravity-driven LNAPL recovery technologies. The Bioslurper Test Plan and Technical Protocol includes three separate LNAPL recovery tests: (1) a skimmer simulation test, (2) a vacuum-assisted bioslurper test, and (3) a groundwater drawdown LNAPL recovery test. The three recovery tests are described in detail in Section 7.3 of the Test Plan and Technical Protocol.

The bioslurper operating parameters that will be measured during operation are vapor discharge, aqueous effluent, LNAPL recovery volume rates, vapor discharge volume rates, and groundwater discharge volume rates. Vapor monitoring will consist of intermittent monitoring of TPH using hand-held instruments supplemented by two samples collected for detailed laboratory analysis. A total of two samples of aqueous effluent will be collected for analysis of BTEX and TPH. Recovered LNAPL volume will be recorded using an in-line flow-totalizing meter. The off-gas discharge volume will be measured using a calibrated pitot tube, and groundwater discharge volume will recorded using an in-line flow-totalizing meter. Section 8.0 of the Test Plan and Technical Protocol describes process monitoring of the bioslurper system.

3.3.4 Soil-Gas Permeability Tests

A soil-gas permeability test will be conducted concurrently with startup of the bioslurper operation. Soil-gas permeability data will provide data for estimating the vadose zone radius of influence of the bioslurper system. Soil-gas permeability results also will aid in determining the number of wells required if it is decided to treat the site with a large-scale bioslurper system. The soil-gas permeability test method is described in Section 5.7 of the Test Plan and Technical Protocol.

3.3.5 LNAPL and Water Level Monitoring

During the bioslurper test, the LNAPL and water levels will be monitored in a well adjacent to the extraction well. The top of the monitoring well will be sealed from the atmosphere to contain the subsurface vacuum. Additional information for monitoring of fluid levels during the bioslurper pilot test can be found in Section 4.3.4 of the Test Plan and Technical Protocol.

3.3.6 In Situ Respiration Tests

An in situ respiration test will be conducted after completion of the bioslurper tests. The in situ respiration testing will involve injection of air and helium injection into selected soil-gas monitoring points followed by monitoring changes in concentration of oxygen, carbon dioxide, petroleum hydrocarbons, and helium in soil-gas near the injection point. Measurement of the soil-gas composition typically will be conducted at 2, 4, 6, and 8 hours and then every 4 to 12 hours for about 2 days.

Timing of the tests will be adjusted based on oxygen-use rate. If oxygen depletion occurs rapidly, more frequent monitoring will be conducted. If oxygen depletion is slow, less frequent readings will be acceptable. In situ respiration rates measured during the bioslurper pilot testing will be compared to the respiration rates estimated from Site SS010 bioventing testing. The oxygen utilization rate will be used to estimate the biodegradation rate at the site. Further information on the procedures and data collection for in situ respiration testing is given in Section 5.8 of the Test Plan and Technical Protocol.

3.3.7 Extended Testing

The AFCEE/ERT has the option of extending the operation of the bioslurper system for up to 6 months, if LNAPL recovery rates are promising and viable long-term vapor and aqueous discharge requirements have been identified. If extended testing is to be performed, Robins AFB will need to provide electrical power for long-term operation of the bioslurper pump. Disposition of all generated wastes and routine operation and maintenance of the system will be the Air Force's responsibility. Battelle will provide technical support during the extended testing operation.

3.4 Demobilization

Once all necessary tests have been completed at the Robins AFB sites, the equipment will be disassembled by Battelle staff and moved back to the holding facility, where it will remain until its next destination is determined. Battelle staff will receive this information and will be responsible for shipment of the equipment to the next site before they leave Robins AFB.

4.0 BIOSLURPER SYSTEM DISCHARGE

4.1 Vapor Discharge Disposition

Battelle expects that the operation of the bioslurper test system at the Robins AFB sites may require a waiver or a point source air release registration. At Site SS010, it can be assumed that the concentration of hydrocarbons released to the atmosphere will be approximately 65 lb TPH/day and <1.0 lb benzene/day. This value is based on the average TPH discharge level at two bioslurper test sites (Wright-Patterson AFB and Travis AFB) that are contaminated with jet fuel. The value may vary depending on the TPH concentration of the soil-gas and the permeability of the soils found at Site SS010. The concentration of aromatic hydrocarbons released to the atmosphere at the UST #70 and #72 Site should be less than 65 lb TPH/day. The data for the TPH and benzene vapor discharge levels for five previous bioslurper test sites are presented in Table 3. The relatively large TPH discharge level at Travis AFB is partially due to the extraction rate of the soil-gas vapors. The extraction rate at Travis AFB is the maximum rate a 3-hp pump will achieve and likely will be much less at Robins AFB due to the nature of the site soils. The vapor stream generated by the bioslurper system may be discharged directly to the atmosphere because of the short duration of the test and the low concentration levels of TPH and benzene in the stream. However, a short-term pumping waiver (9 to 10 days per site) is requested.

Table 3. Benzene and TPH Discharge Levels at Previous Bioslurper Test Sites

Site Location	Fuel Type	Extraction Rate (scfm)	Benzene (ppmv)	TPH (ppmv)	Benzene Discharge (lb/day)	TPH Discharge (lb/day)
Wright-Patterson AFB	Jet Fuel	3	ND	595	0.0	1.0
Bolling AFB (Site #1)	No. 2 Fuel Oil	4	0.2	153	0.0003	0.009
Bolling AFB (Site #2)	Gasoline	21	370	70,000	2.3	470.1
Andrews AFB	No. 2 Fuel Oil	8	16	2,000	0.01	0.2
Travis AFB	Jet Fuel	20	100	10,800	0.58	126.4

ND = Not detected

Based on site visits, site layouts, and locations it has been determined that no unacceptable health risks will result from the bioslurper pilot tests at Robins AFB. However, to ensure the safety and regulatory compliance of the bioslurper system, vapor discharge samples (TPH, O_2, and CO_2) will be collected periodically throughout the bioslurper pilot test, and field soil-gas screening instruments will be used to monitor vapor discharge concentration variability. The volume of vapor discharge will be monitored daily using airflow instruments. If state regulatory requirements will not permit the expected amount of organic vapor discharge to the atmosphere, the Base POC should inform AFCEE and Battelle so that alternative plans can be made prior to mobilization to the site. Table 4 provides information typically required to complete an air release registration form. Highly stringent discharge allowances may compromise AFCEE's ability to conduct site testing. Therefore, a short-term discharge allowance is requested.

4.2 Aqueous Influent/Effluent Disposition

The flowrate of groundwater pumped by the bioslurper will be less than 5 gpm (estimated at 1.25 gpm). However, it may be necessary to obtain a groundwater pumping waiver or registration permit in Georgia. If one is required, the Base POC will inform Battelle of the necessary steps in obtaining the waiver or permit.

Operation of the bioslurper system will generate an aqueous waste discharge that will be passed through an oil/water separator. The intention of Battelle staff will be to dispose of the wastewater by discharge directly to the Base industrial wastewater treatment plant (IWTP). If existing Base wastewater channels can be used, no water discharge permits will be required. A copy of the letter that details the estimated concentrations of TPH and benzene expected in the system wastewater discharge is included in Appendix D. The expected levels of organic discharge in the wastewater

stream will be within the operational parameters of the IWTP and the downstream sewage treatment plant.

Table 4. Air Release Summary Information

Data Item	Air Release Information
Contractor Point of Contact	Jeff Kittel, (614) 424-6122
Contractor address	Battelle, 505 King Avenue, Columbus, OH 43201
Estimated total quantity of petroleum product to be recovered	TBD
Description of petroleum product to be recovered	Site SS010: JP-4 Jet Fuel
	UST #70 and #72 Site: JP-4 Jet Fuel
Planned date of test start	Tentatively scheduled as July 10, 1995
Test duration	9 days (active pumping)
Maximum expected VOC concentration in air	~65 lb/day (65 lb TPH/day, ~0.25 lb benzene/day)
Expected contaminants in air release	TPH, benzene
Stack height above ground level	10 ft

4.3 Free-Product Recovery Disposition

The bioslurper system will recover free-phase product from the pilot tests performed at Robins AFB. Free product recovered by the bioslurping tests will be turned over to the Base for disposal and/or recycling. The volume of free product recovered from the Base will not be known until the tests have been performed. The maximum recovery rate for this system is 5 gpm, but the actual rate of LNAPL recovery likely will be much lower.

5.0 SCHEDULE

The schedule for the bioslurper fieldwork at Robins AFB will depend on approval of the project Test Plan. Battelle will determine a definitive schedule as soon as possible after approval is received. Battelle will have two to three staff members on site for approximately 2 weeks to conduct all necessary pilot testing. At the conclusion of the field testing at Robins AFB, Battelle staff will return their Base passes and will remove all bioslurper field testing equipment from the Base before they leave the site.

6.0 PROJECT SUPPORT ROLES

This section outlines some of the major functions of personnel from Battelle, Robins AFB, and AFCEE during the bioslurper field test.

Table 5. Health and Safety Information Checklist

Emergency Contacts	Name	Telephone Number
Hospital Emergency Room:		
Point of Contact:		
Fire Department:		
Emergency Unit (Ambulance):		
Security:		
Explosives Unit:		
Community Emergency Response Coordinator:		
Other:		
Program Contacts	Patrick Haas	210-536-4314
Air Force:	Mike Stevens	912-926-0983
Battelle:	Jeff Kittel	614-424-6122
Other:	Eric Drescher	614-424-3088
Emergency Routes		
Hospital (maps attached)		
Other:		

6.3 AFCEE Activities

The AFCEE POC will act as a liaison between Battelle and Base staff. The AFCEE POC will ensure that all necessary permits are obtained and the space required to house the bioslurper field equipment is found.

The following is a listing of Battelle, AFCEE, and Robins Base staff who can be contacted in cases of emergency and/or for required technical support during the bioslurper field initiative tests at Robins AFB.

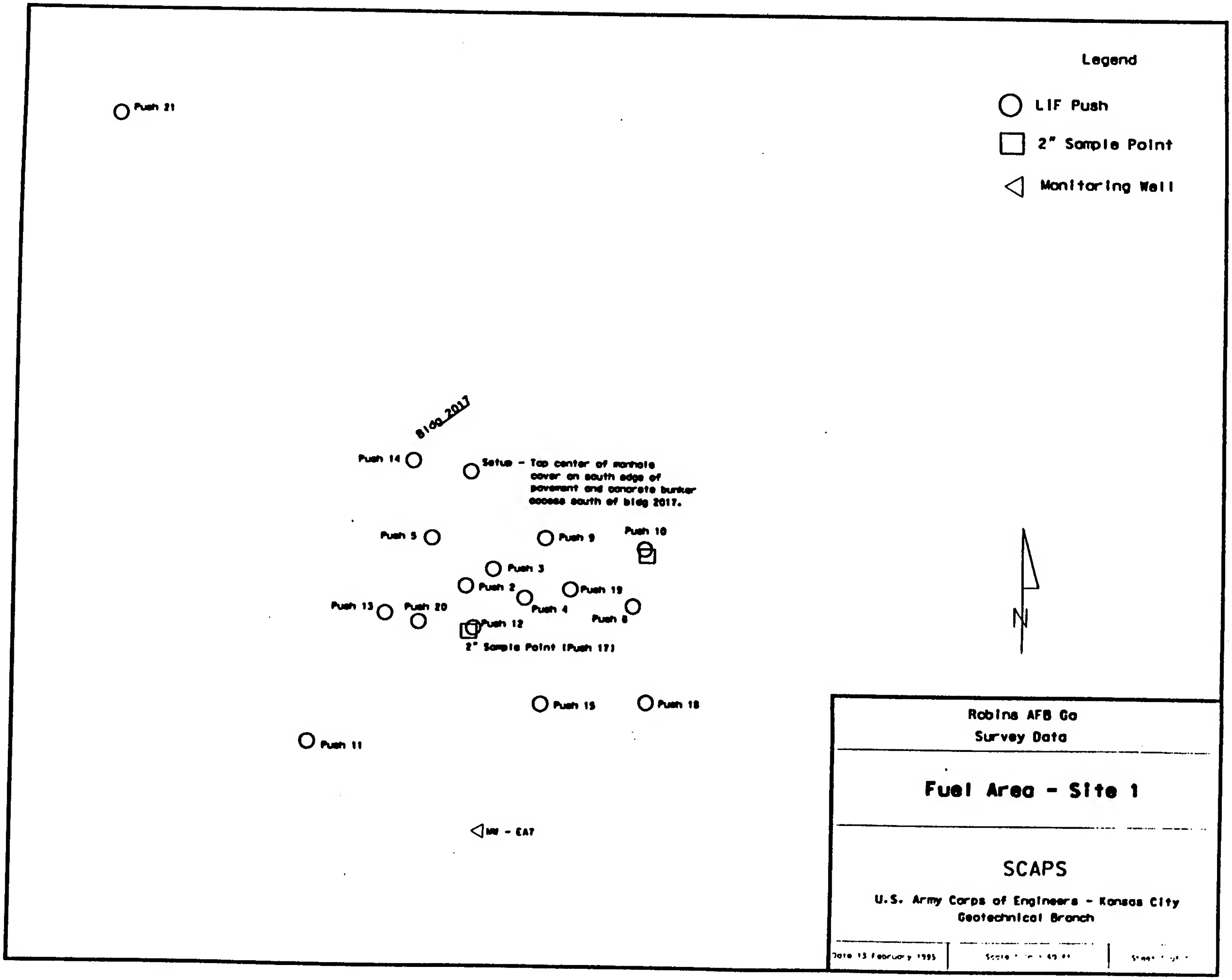
Battelle POCs	Jeff Kittel Eric Drescher	614-424-6122 614-424-3088
AFCEE POC	Patrick Haas	210-536-4314
Robins AFB POC	Mike Stevens	912-926-0983
Regulator POCs		
Air:	______________	______________
Water:	Tom Kirby	______________

7.0 REFERENCES

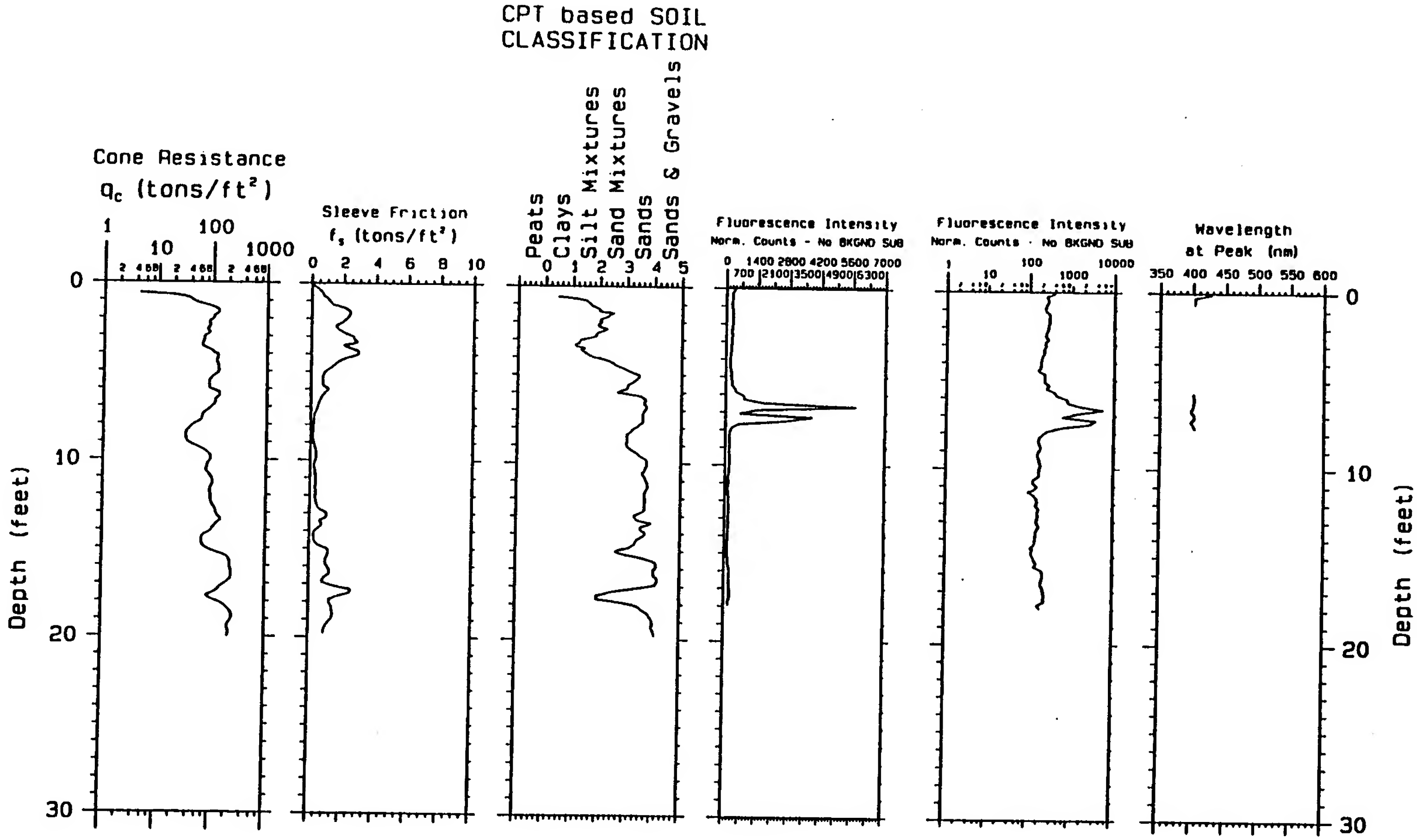
Battelle. 1995. *Test Plan and Technical Protocol for Bioslurping*, Report prepared by Battelle Columbus Operations for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

APPENDIX A

CONE PENETROMETER-LASER INDUCED FLUORESCENCE SENSOR DATA FOR ROBINS AFB, GA


Legend
LIF Push
2" Sample Point
Monitoring Well
Push 21
Bldg 2017
Push 14
Setup - Top center of manhole cover on south edge of pavement and concrete bunker access south of bldg 2017.
Push 5
Push 9
Push 10
Push 3
Push 2
Push 19
Push 4
Push 13
Push 20
Push 12
Push 8
2" Sample Point (Push 17)
Push 15
Push 18
Push 11
MW - EAT
N
Robins AFB Ga
Survey Data
Fuel Area - Site 1
SCAPS
U.S. Army Corps of Engineers - Kansas City
Geotechnical Branch
Date 13 February 1995

1RBND1
LEFT BLANK
DUMMY PUSH



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

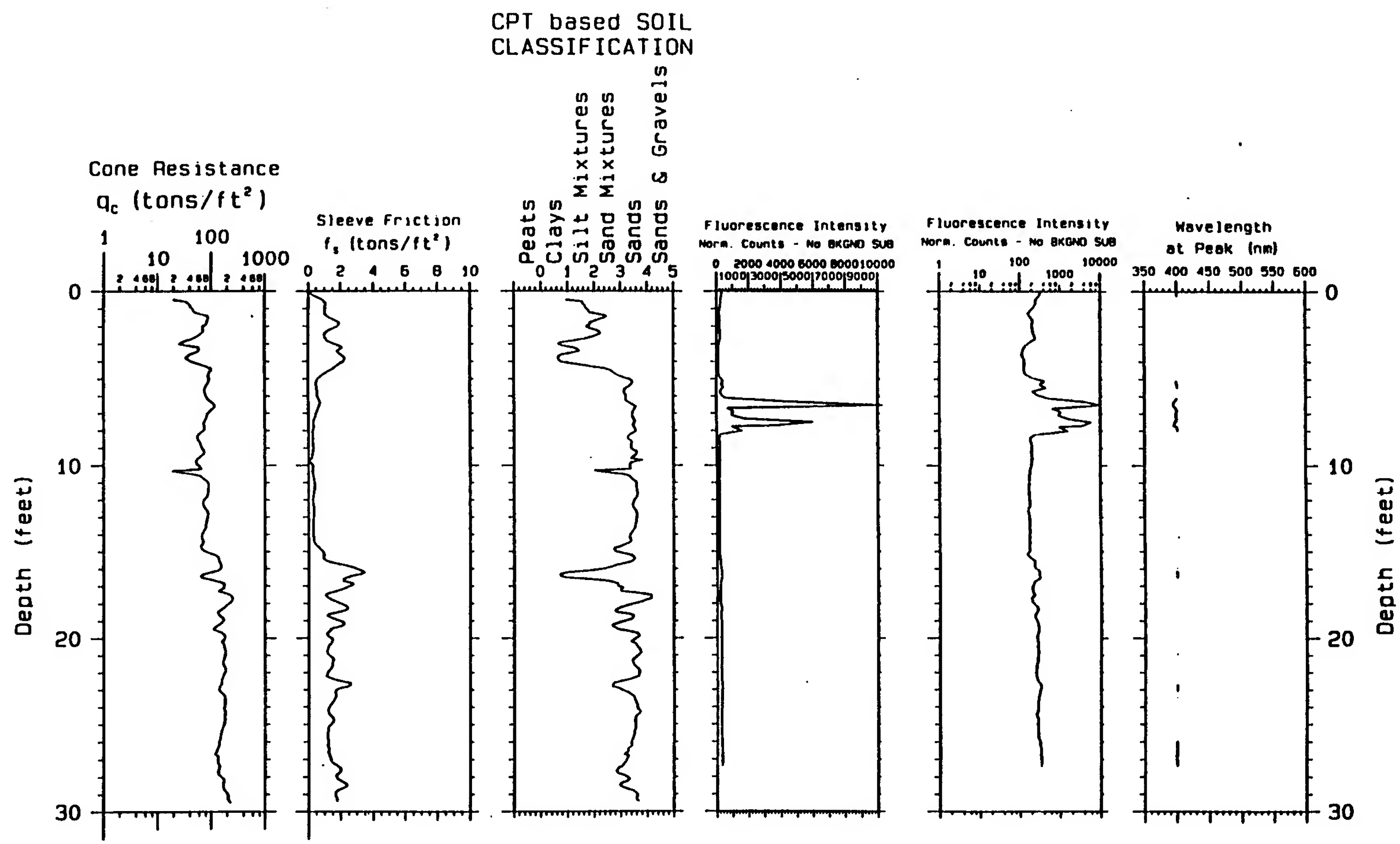
Site Characterization and Analysis Penetrometer System

Project; Robins AFB <NEW>

Probe Depth; 20.17

CPT; 2RBNL1

Probing date; 02-09-1995



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

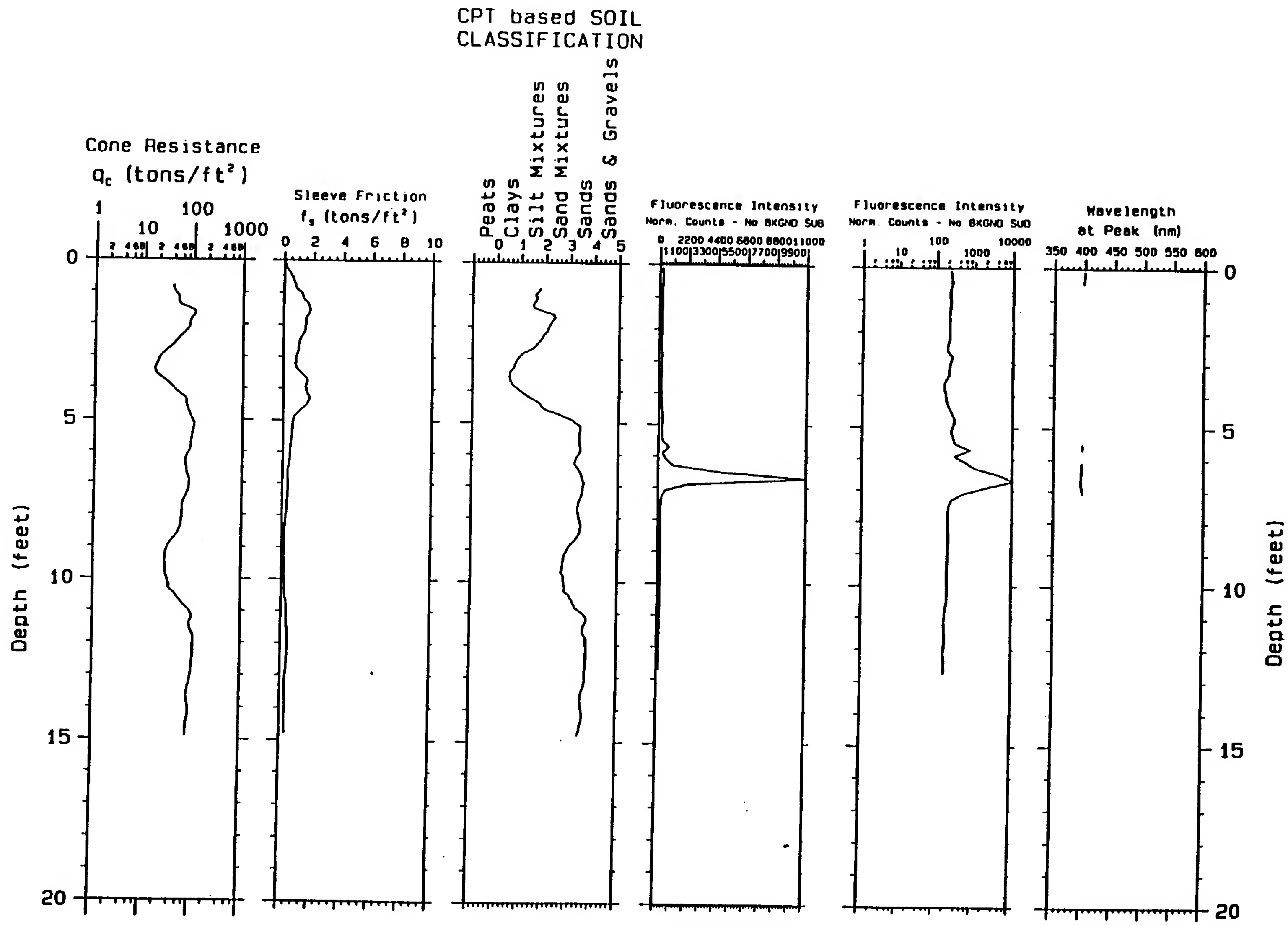
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 29.62

CPT; 3RBNL1

Probing date; 02-09-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

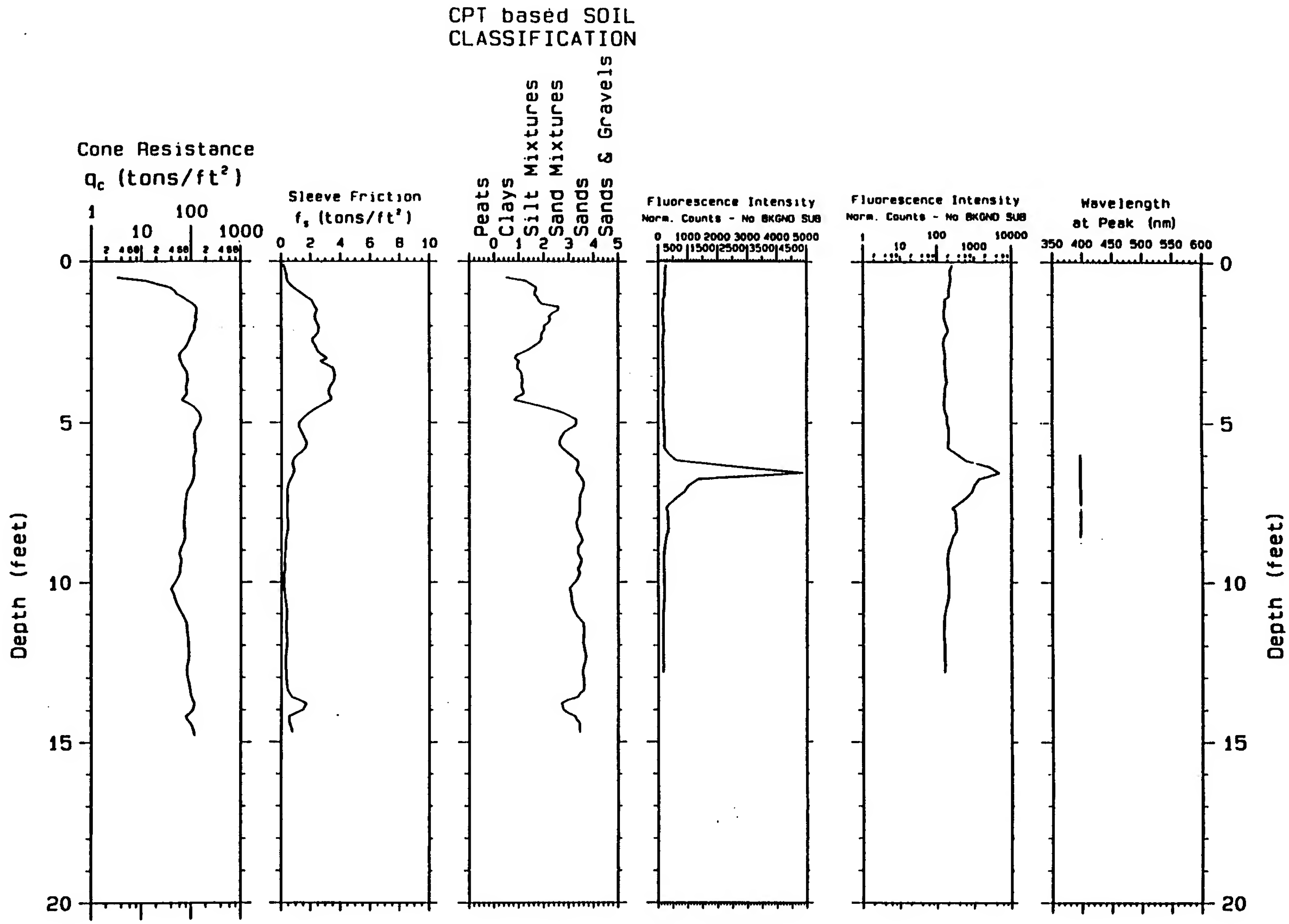
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 15.05

Probing date; 02-09-1995

CPT; 4RBNL1



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 15.00

CPT; 5RBNL1

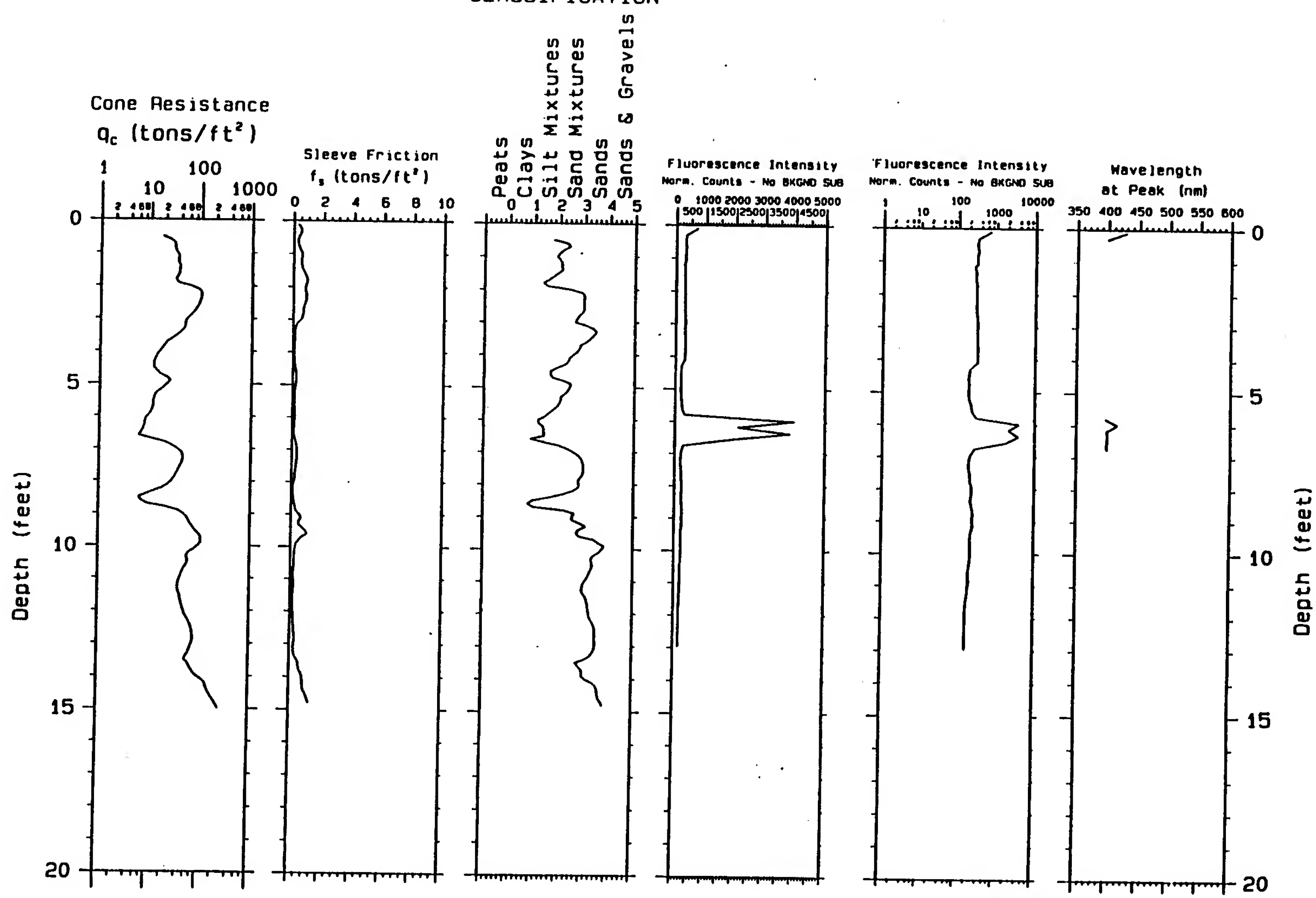
Probing date; 02-09-1995

6RBNL1
LEFT BLANK

1.5' concrete

7RBNL1
LEFT BLANK

1.5' cacrete



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

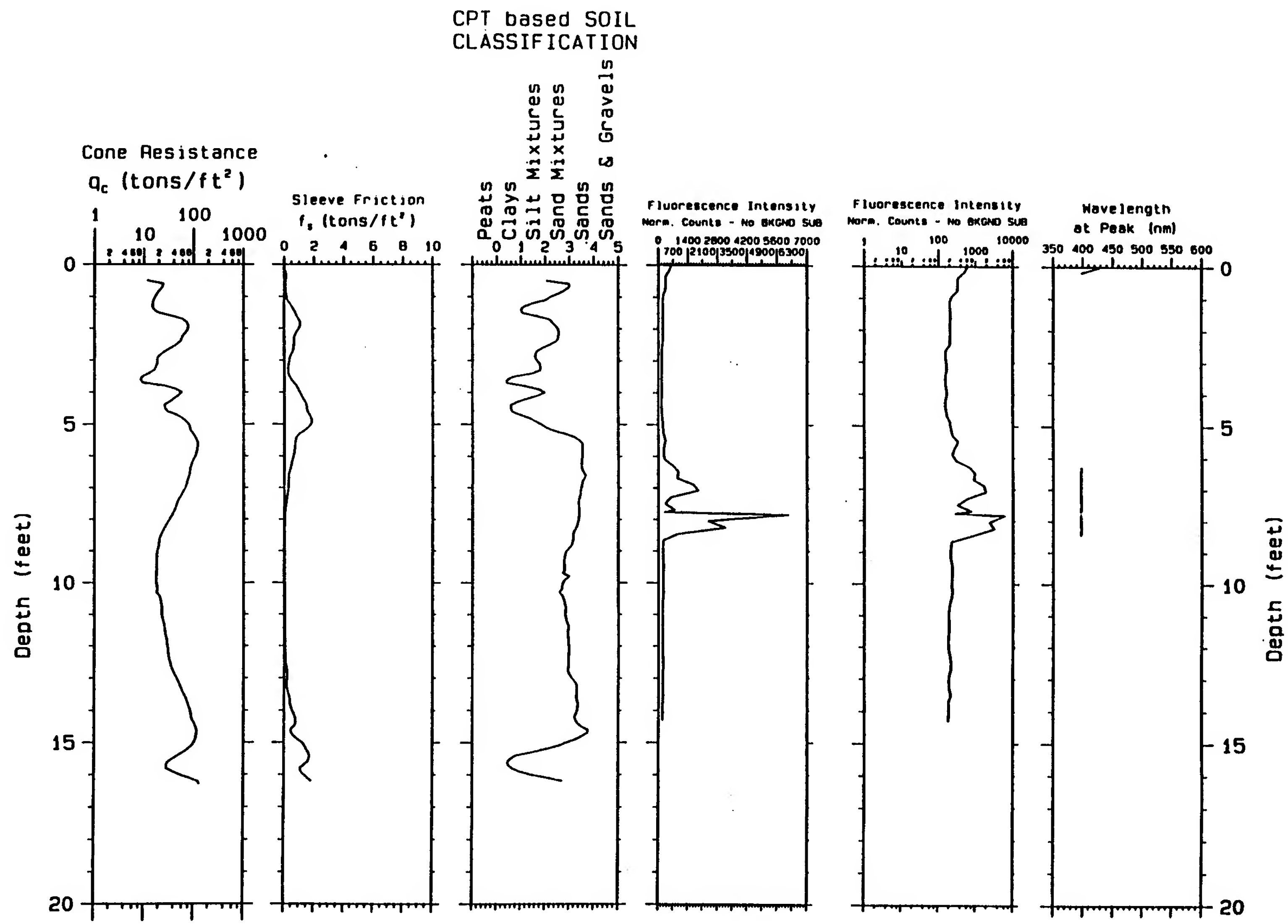
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 15.11

CPT; 8RBNL1

Probing date; 02-09-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.45

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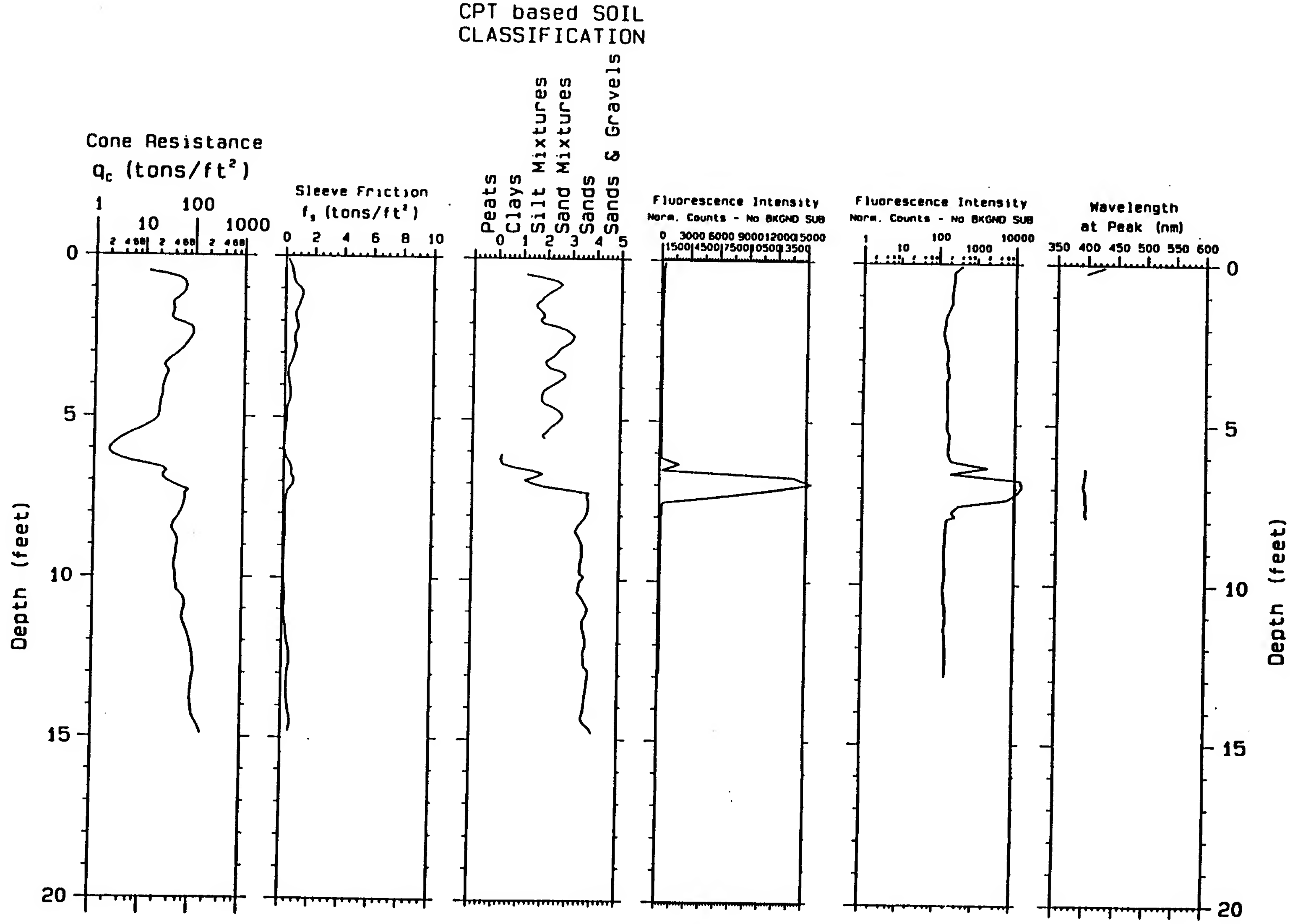
Probing date; 02-09-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

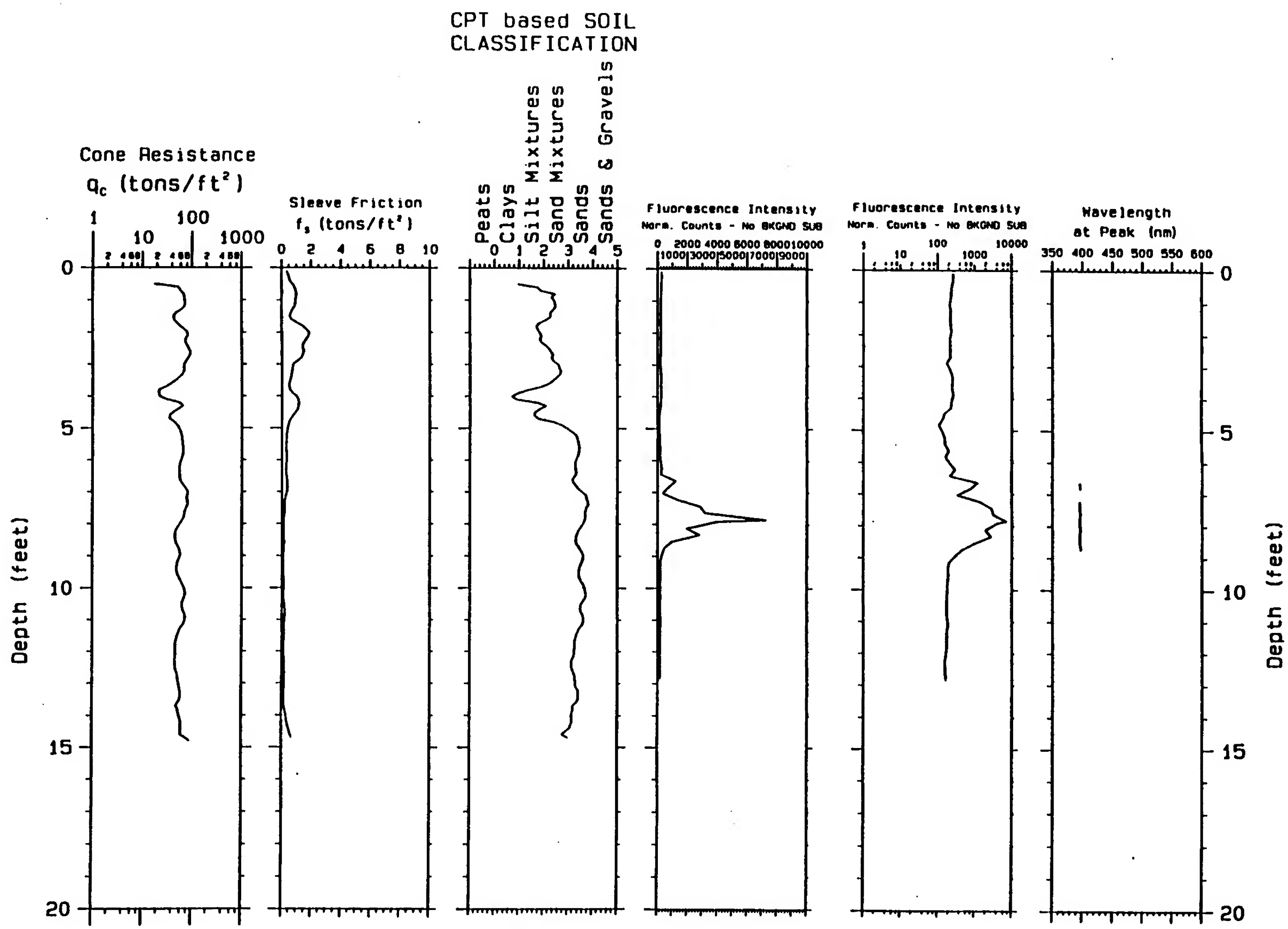
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 15.04

CPT; 10RBNL1

Probing date; 02-09-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

Probing date; 02-09-1995

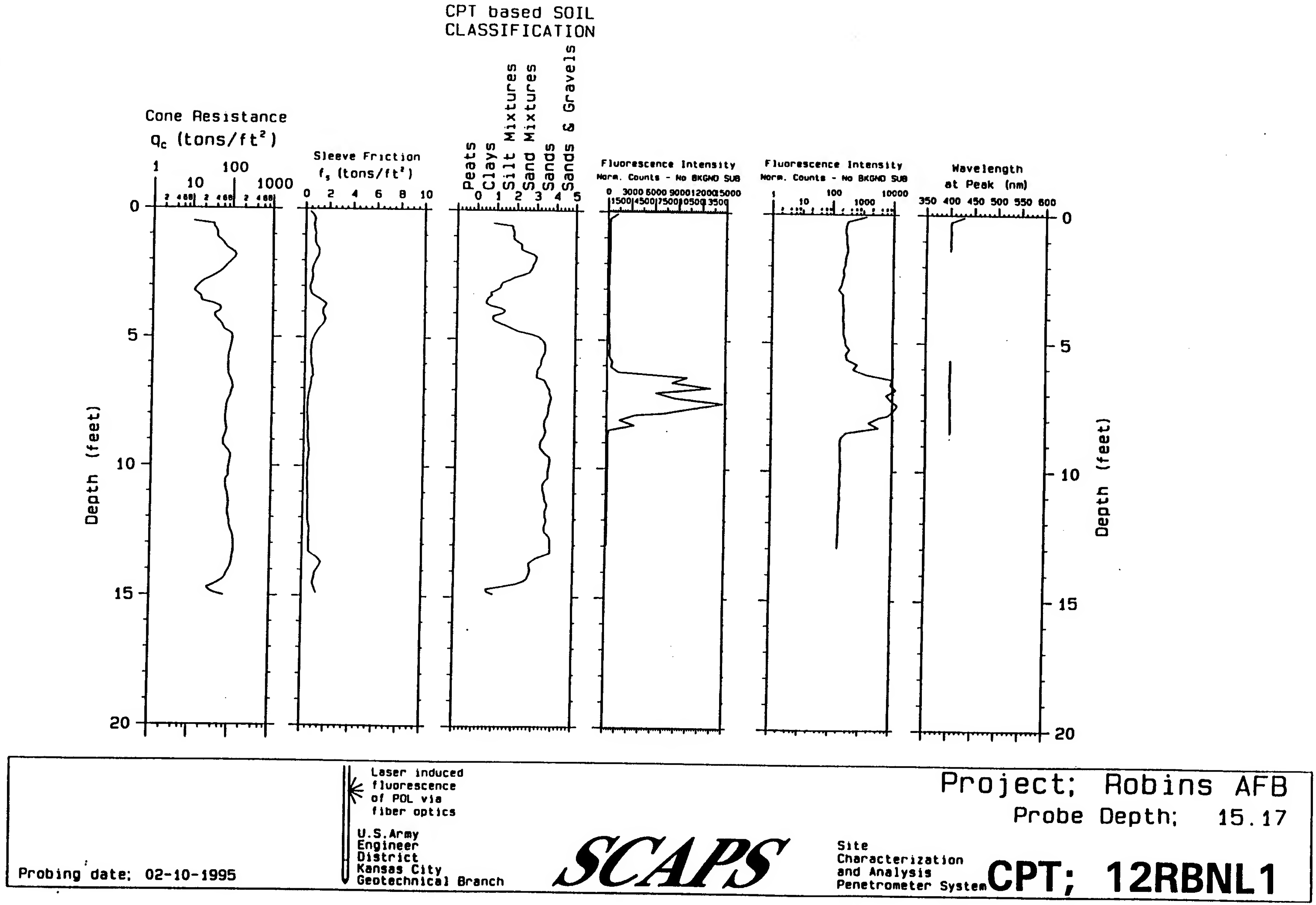
SCAPS

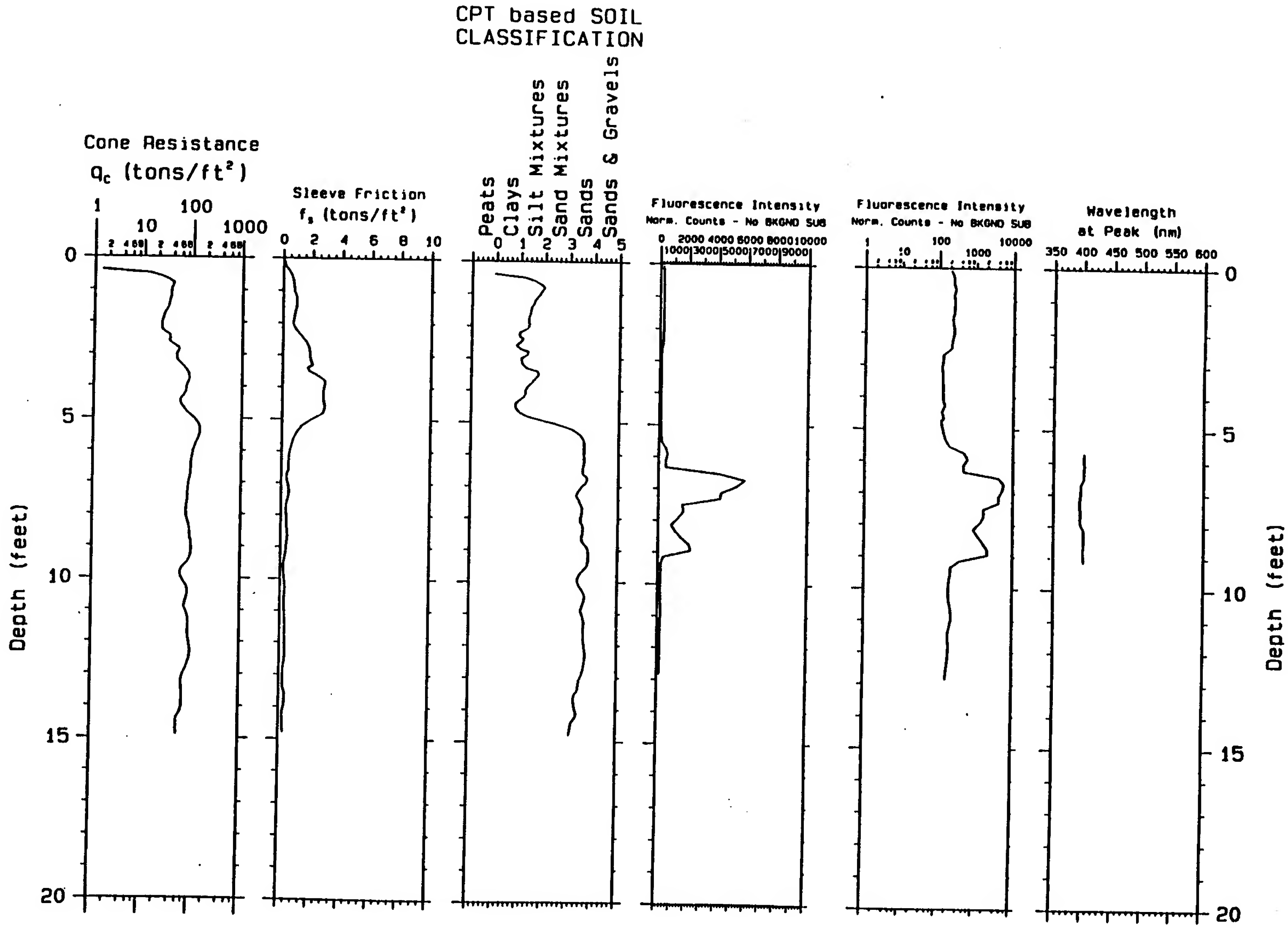
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 15.00

CPT; 11RBNL1


CPT based SOIL CLASSIFICATION
Cone Resistance
q_c (tons/ft²)
Sleeve Friction
f_s (tons/ft²)
Peats
Clays
Silt Mixtures
Sand Mixtures
Sands
Sands & Gravels
Fluorescence Intensity
Norm. Counts - No BKGND SUB
Fluorescence Intensity
Norm. Counts - No BKGND SUB
Wavelength
at Peak (nm)
Depth (feet)
Depth (feet)
Laser induced fluorescence of POL via fiber optics
U.S.Army Engineer District Kansas City Geotechnical Branch
SCAPS
Site Characterization and Analysis Penetrometer System
Project; Robins AFB
Probe Depth; 15.17
CPT; 12RBNL1
Probing date: 02-10-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

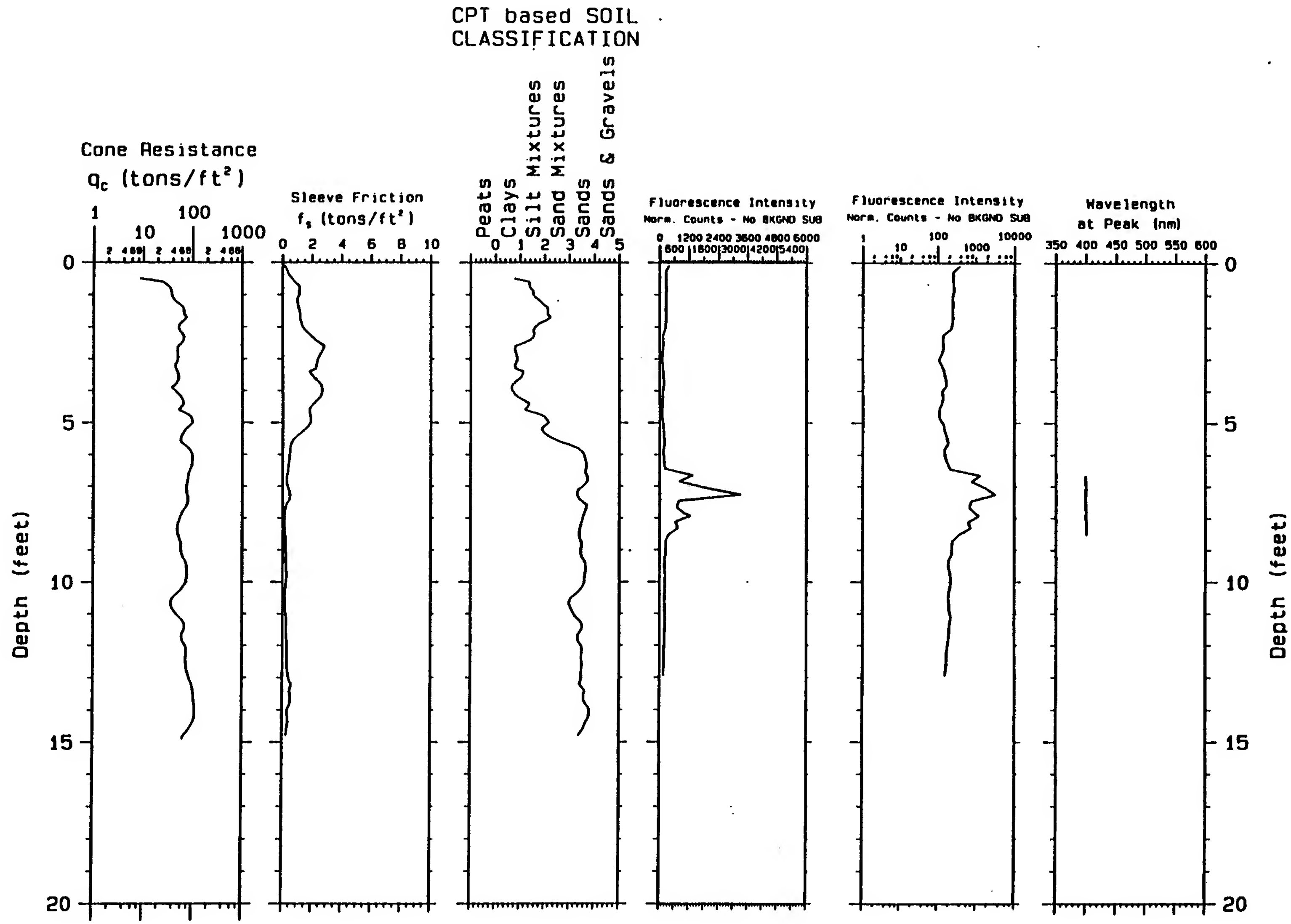
SCAPS Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 15.09

Probing date; 02-10-1995

CPT; 13RBNL1



Project; Robins AFB

Probe Depth; 15.09

Laser induced fluorescence of POL via fiber optics

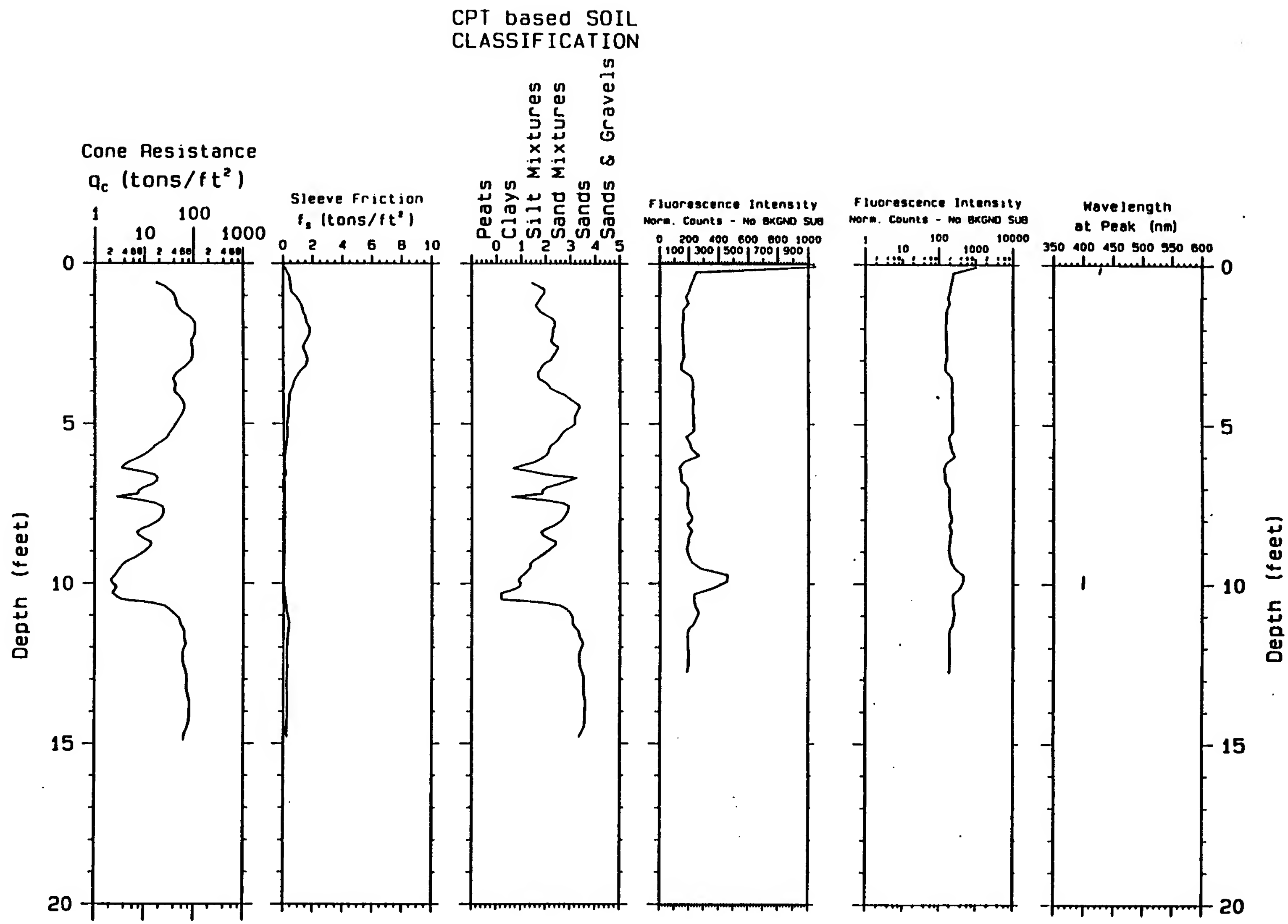
U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

CPT; 14RBNL1

Probing date; 02-10-1995



Probing date; 02-10-1995	Project; Robins AFB
	Probe Depth; 15.05

Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

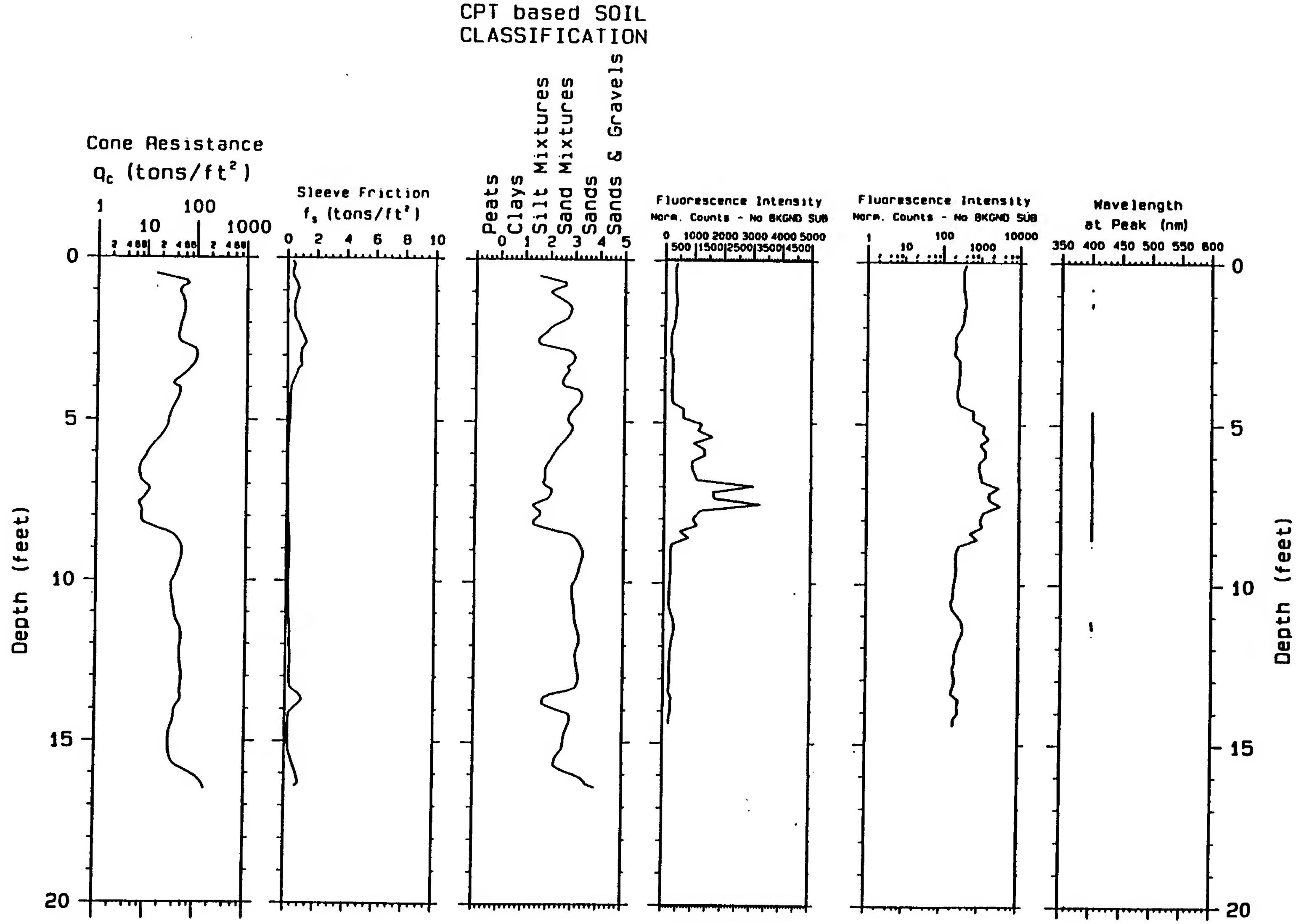
SCAPS

Site Characterization and Analysis Penetrometer System

CPT; 15RBNL1

16RBNW1
2" PVC
SAMPLE POINT
DEPTH 8 FT
NEAR PUSH
10RBNL1

17 RBNW1
2" PVC
SAMPLE POINT
DEPTH 8 FT
NEAR PUSH
12RBNL1



Project; Robins AFB

Probe Depth; 16.62

Laser induced fluorescence of POL via fiber optics

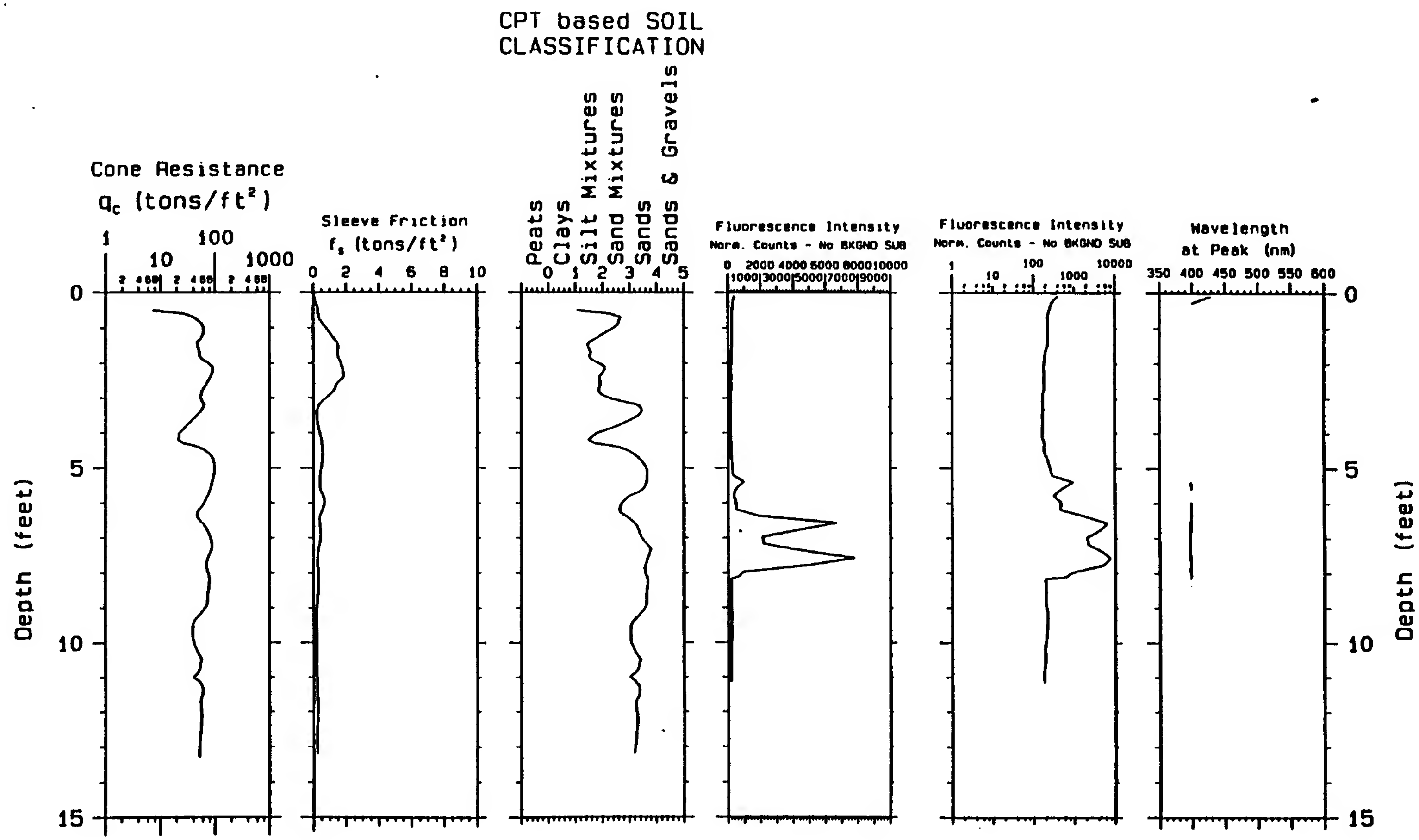
U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

CPT; 18RBNL1

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

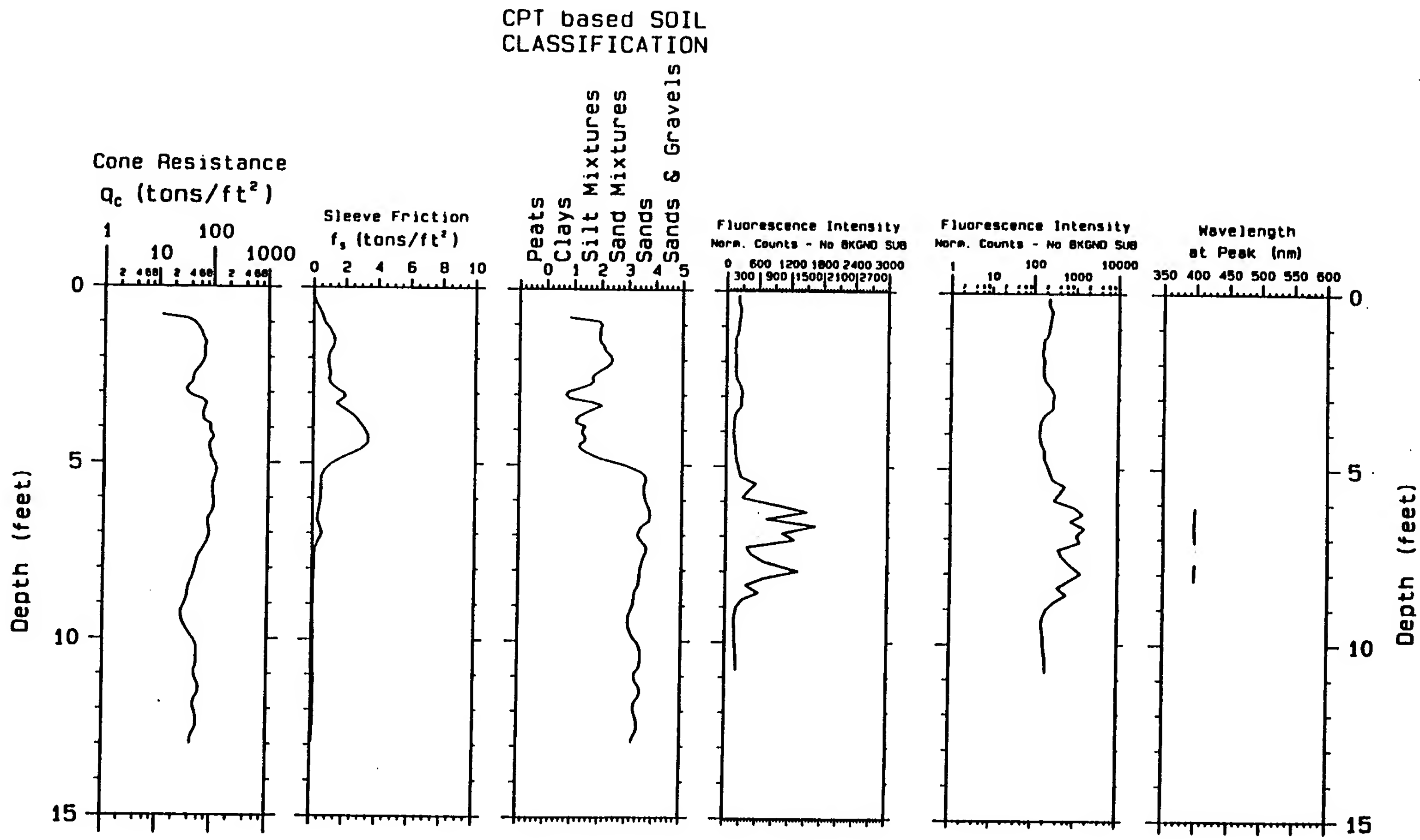
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 13.48

CPT; 19RBNL1

Probing date; 02-13-1995



Project; Robins AFB

Probe Depth; 13.13

Laser induced fluorescence of POL via fiber optics

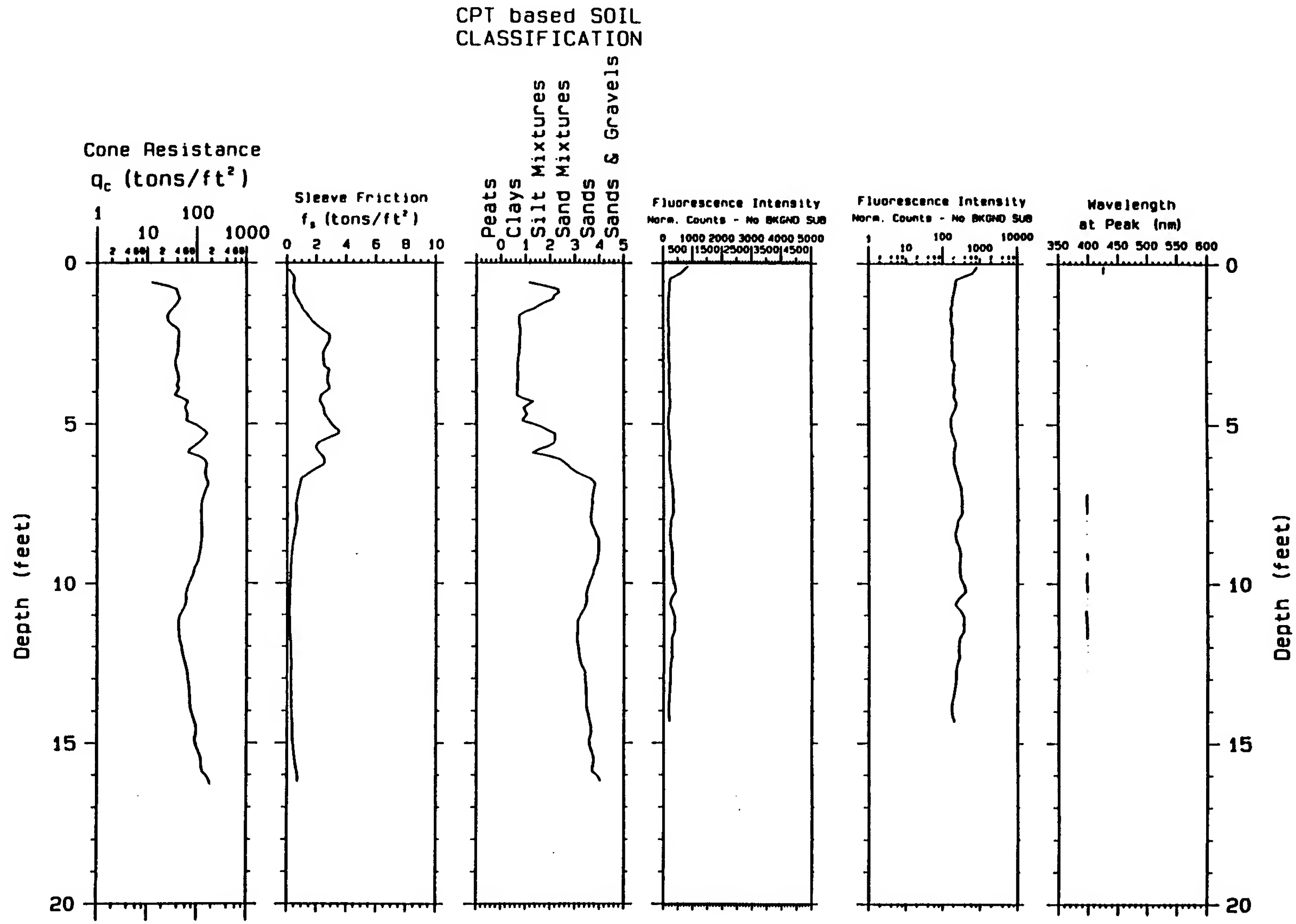
U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

CPT; 20RBNL1

Probing date; 02-13-1995



Probing date; 02-13-1995

Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

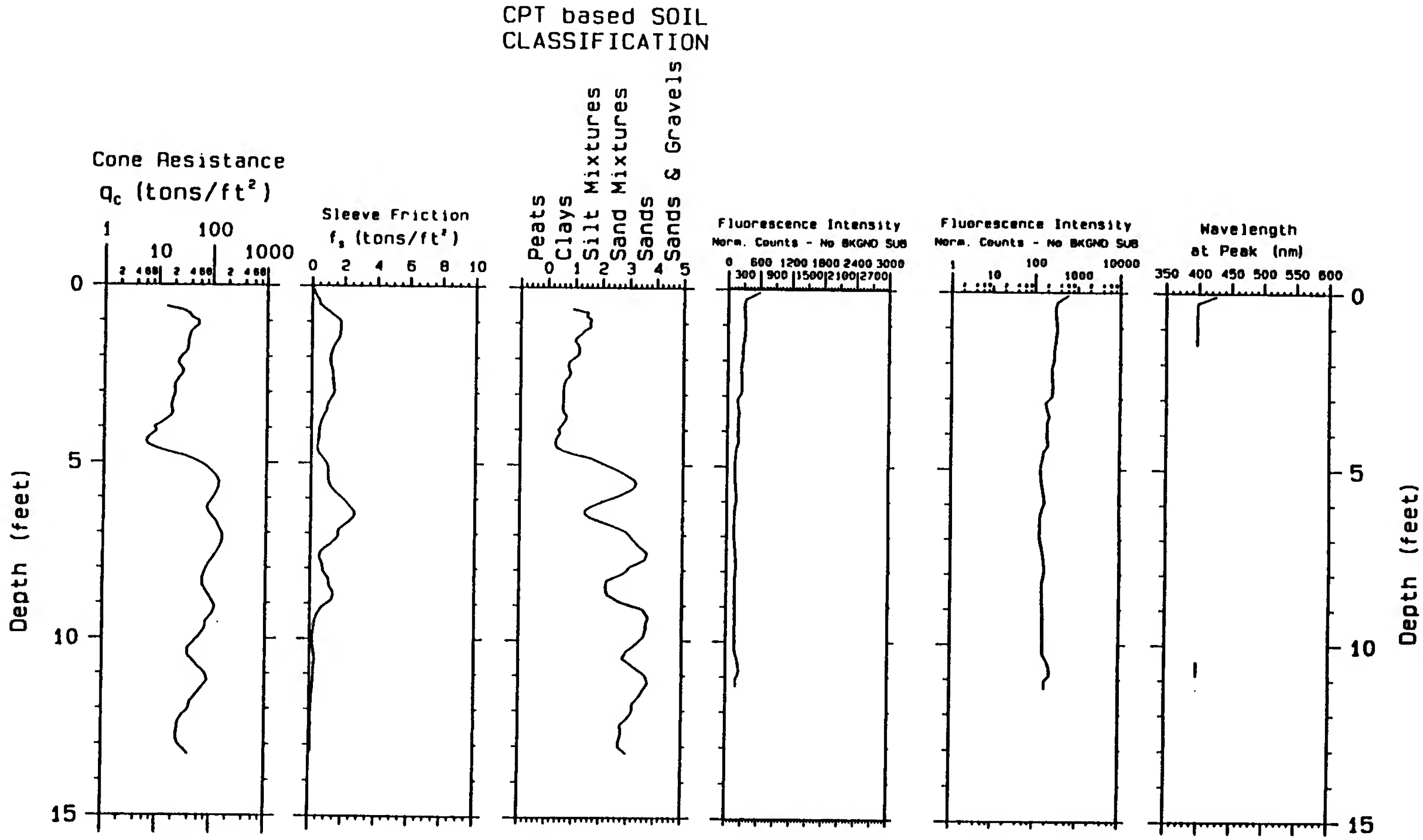
SCAPS

Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.53

CPT; 21RBNLP



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

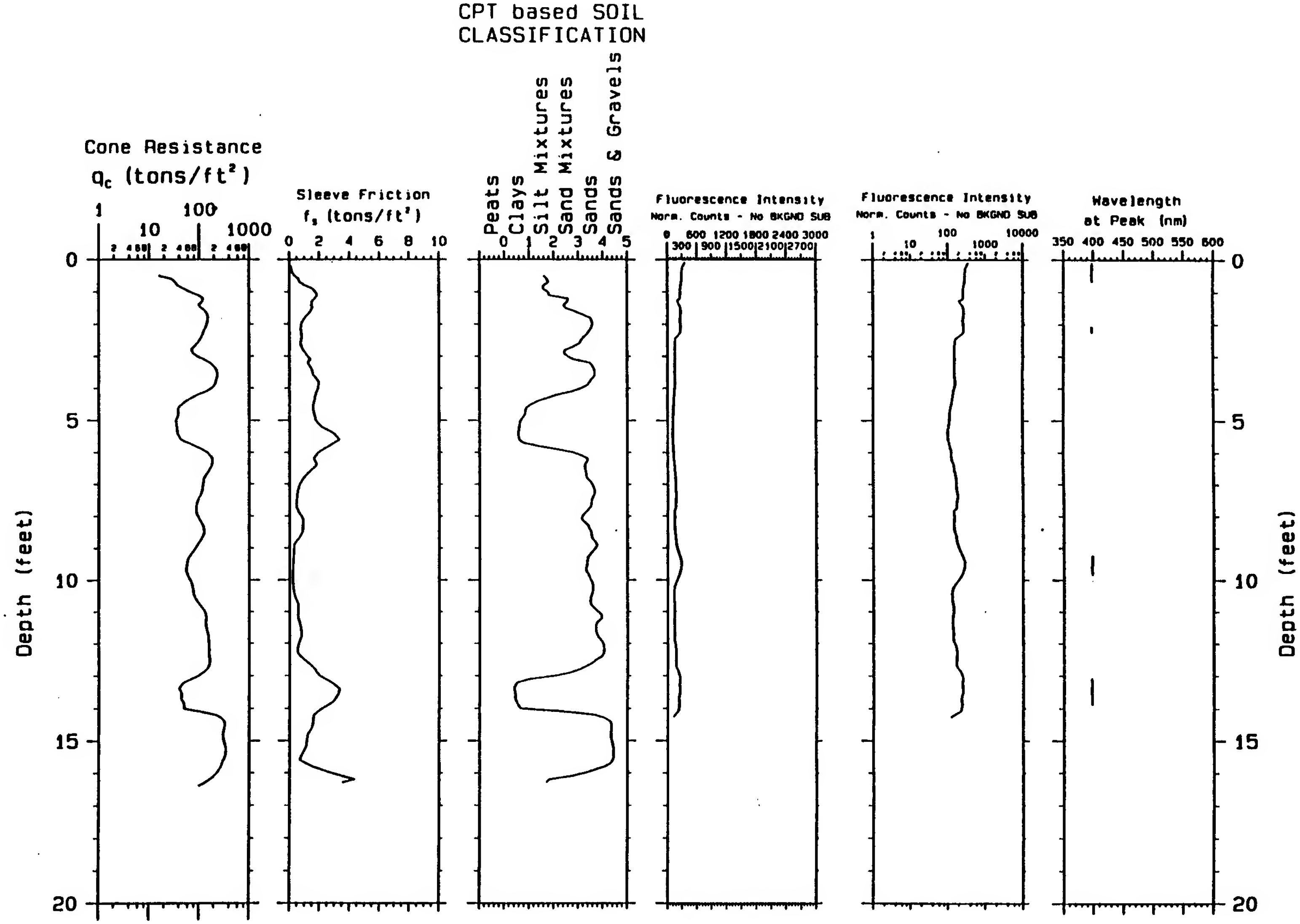
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 13.49

CPT; 22RBNLP

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

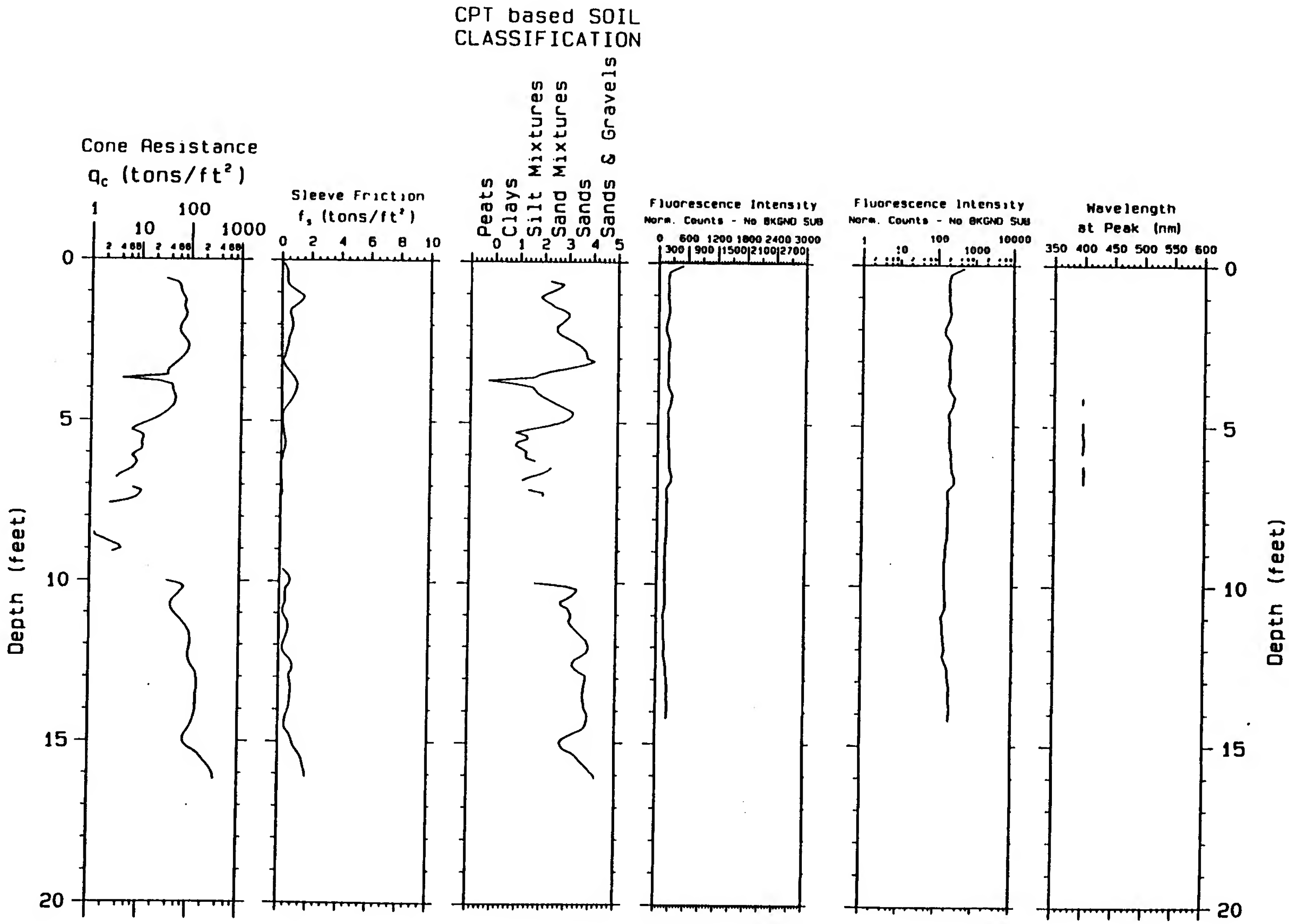
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.52

CPT; 23RBNLP

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

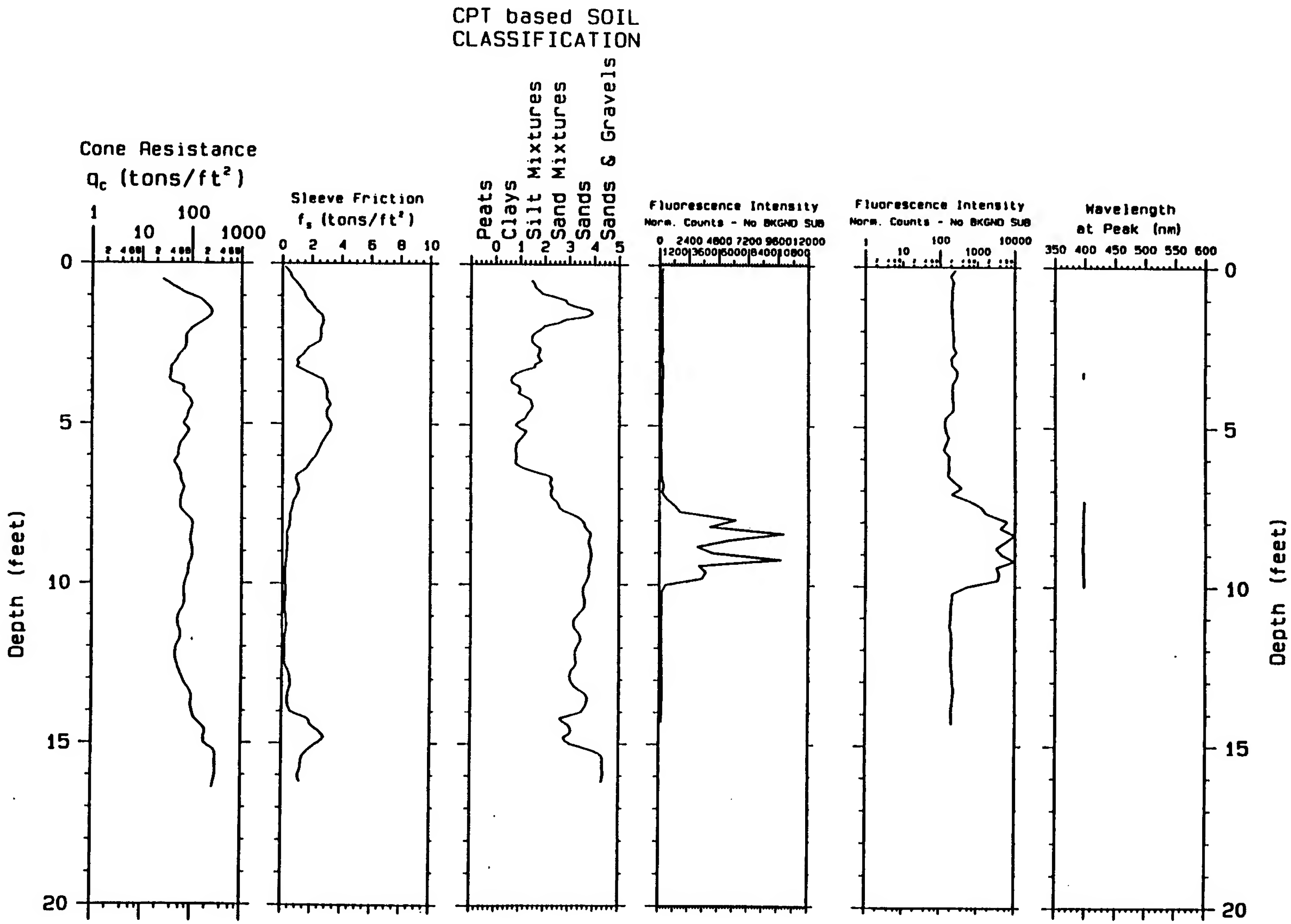
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.38

CPT; 24RBNLP

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

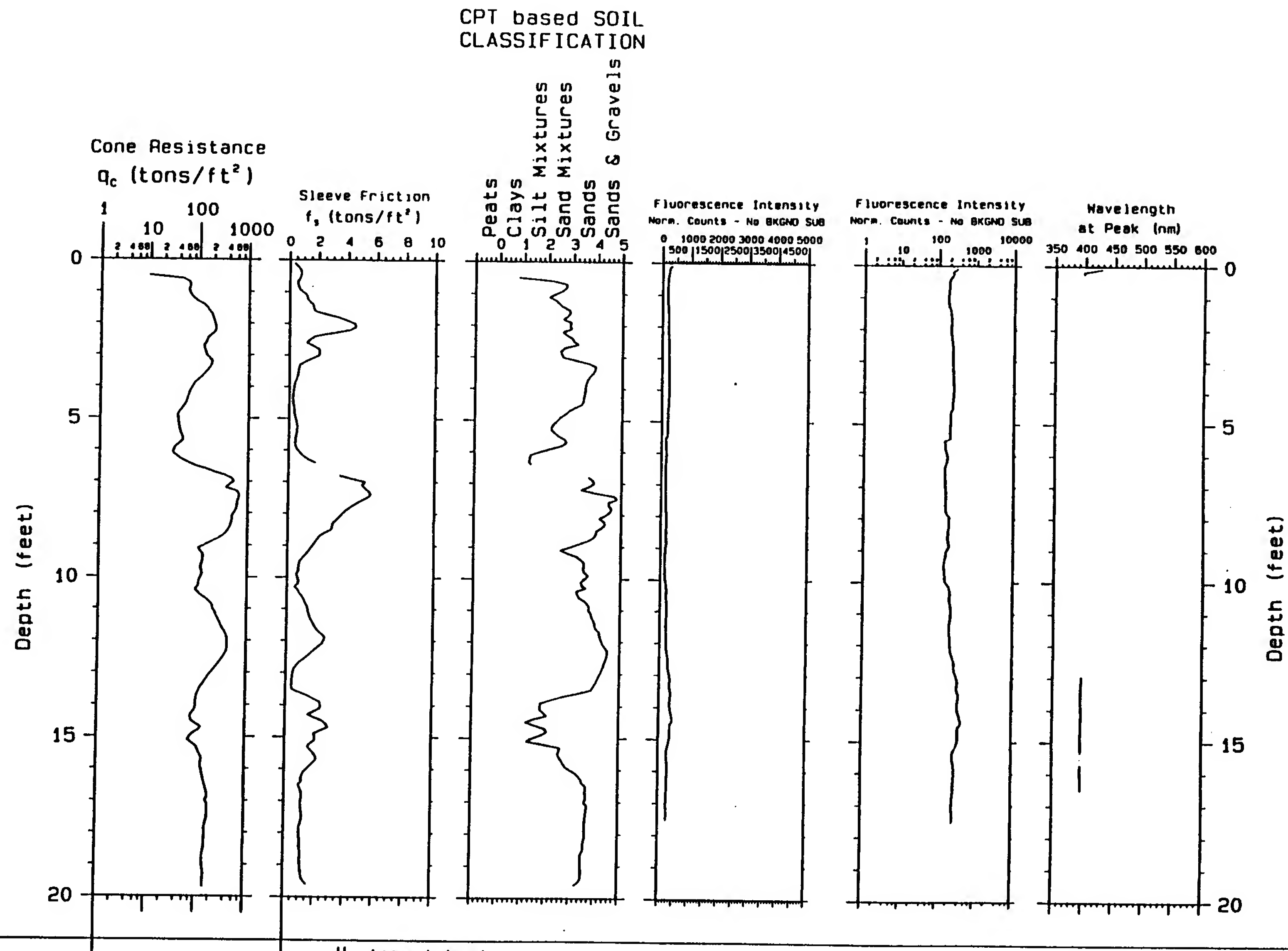
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.51

CPT; 25RBNLP

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

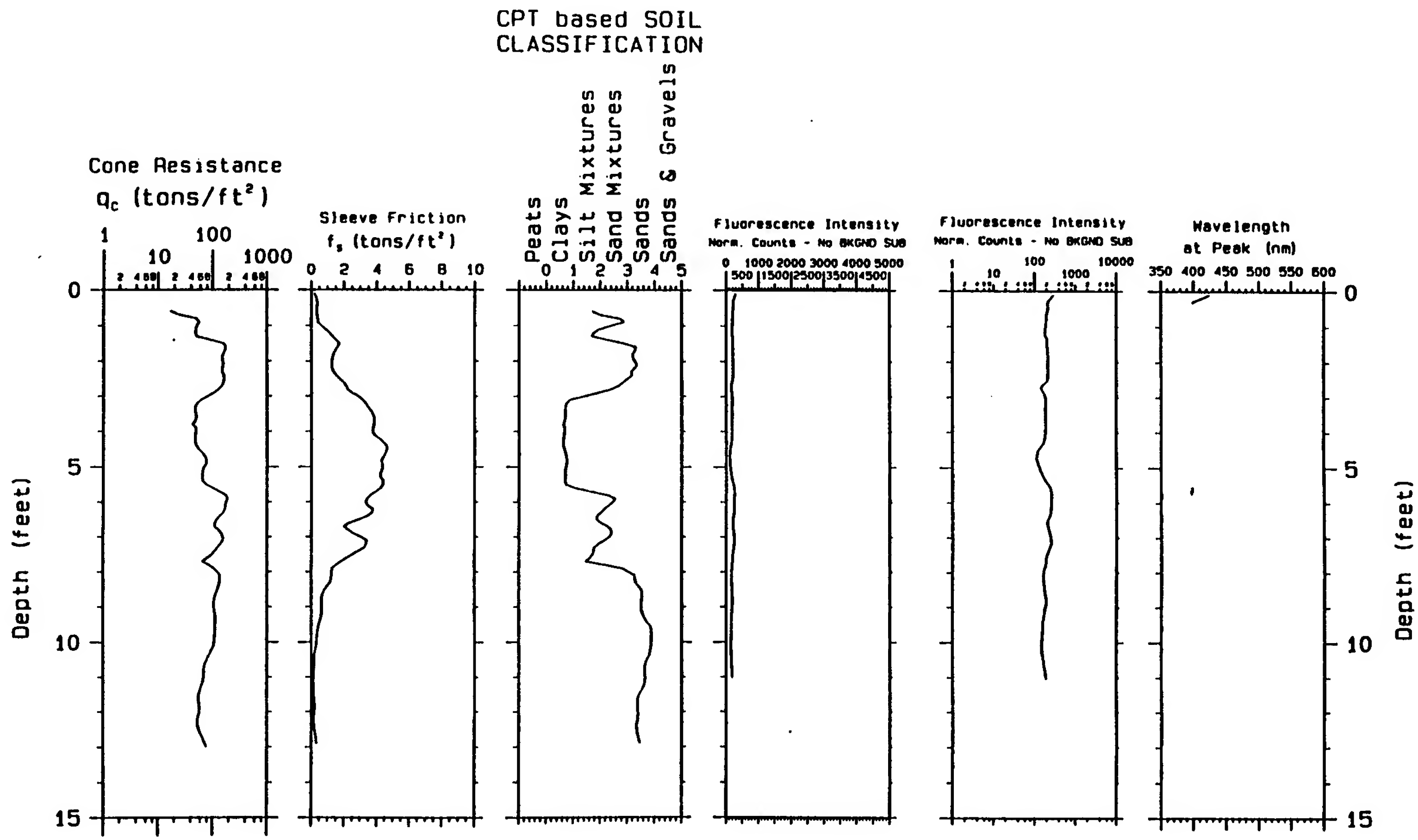
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 19.85

CPT; 26RBNLP

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

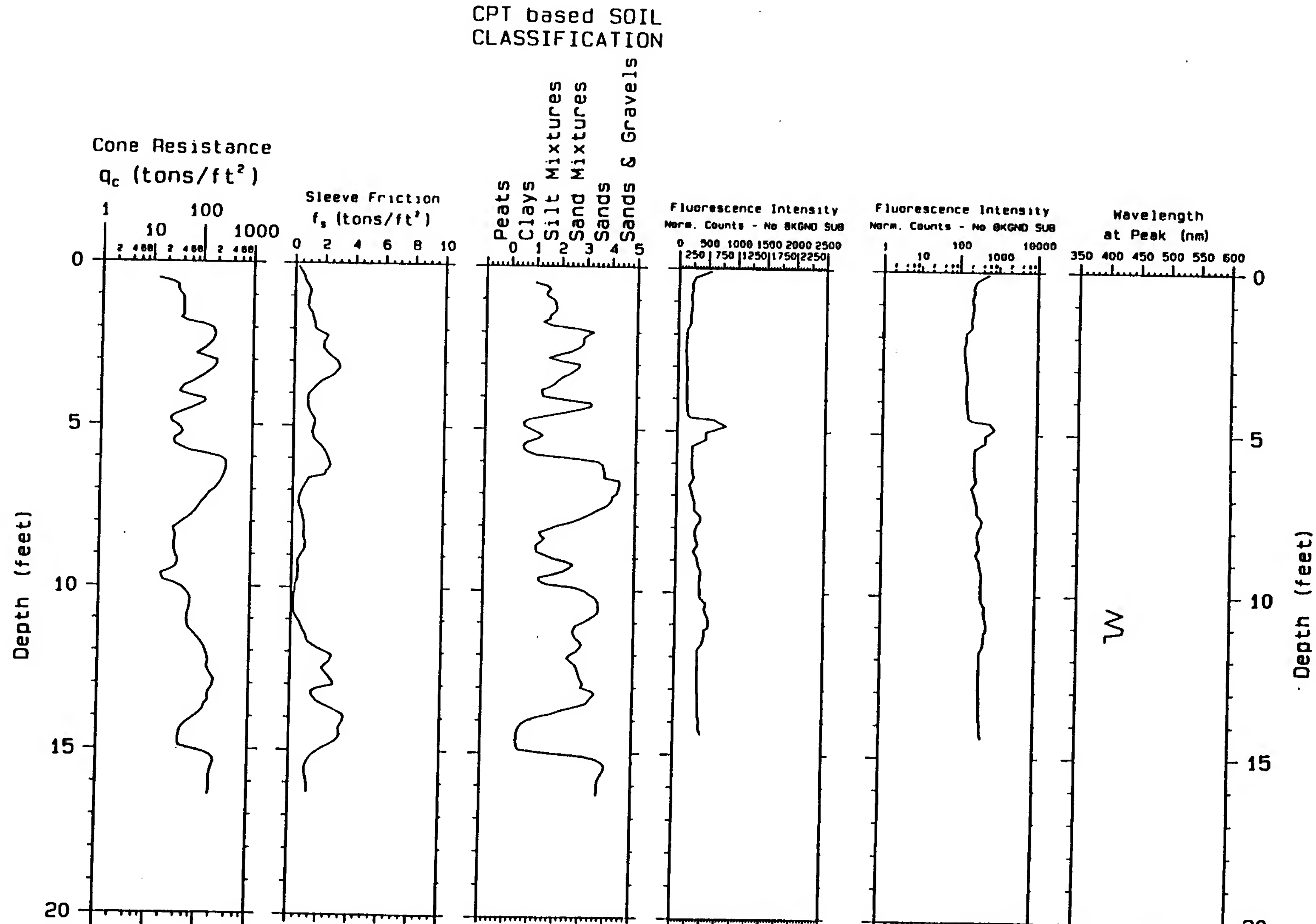
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 13.18

CPT; 27RBNLP

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

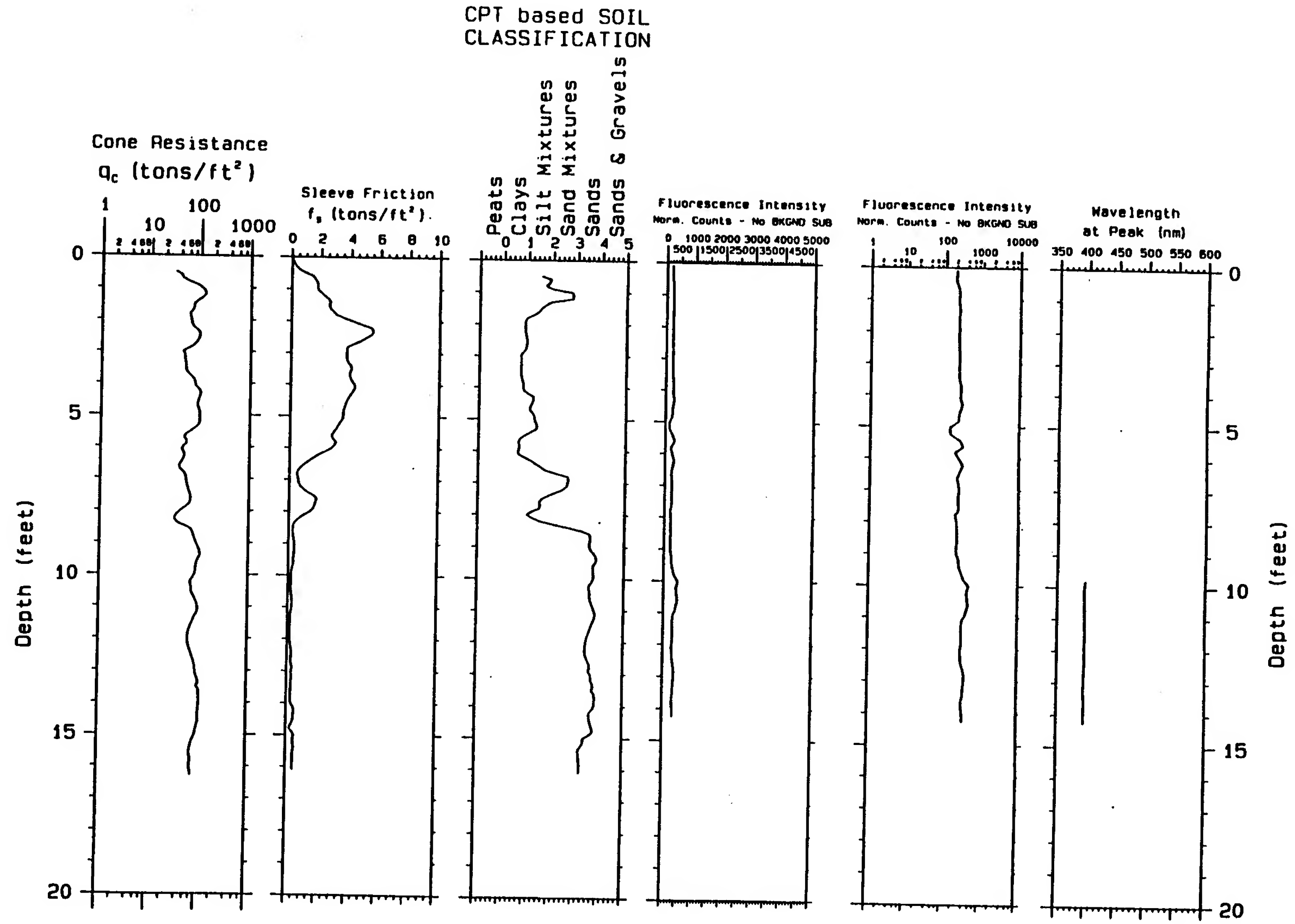
Probing date; 02-13-1995

SCAPS Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.56

CPT; 28RBNLP



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

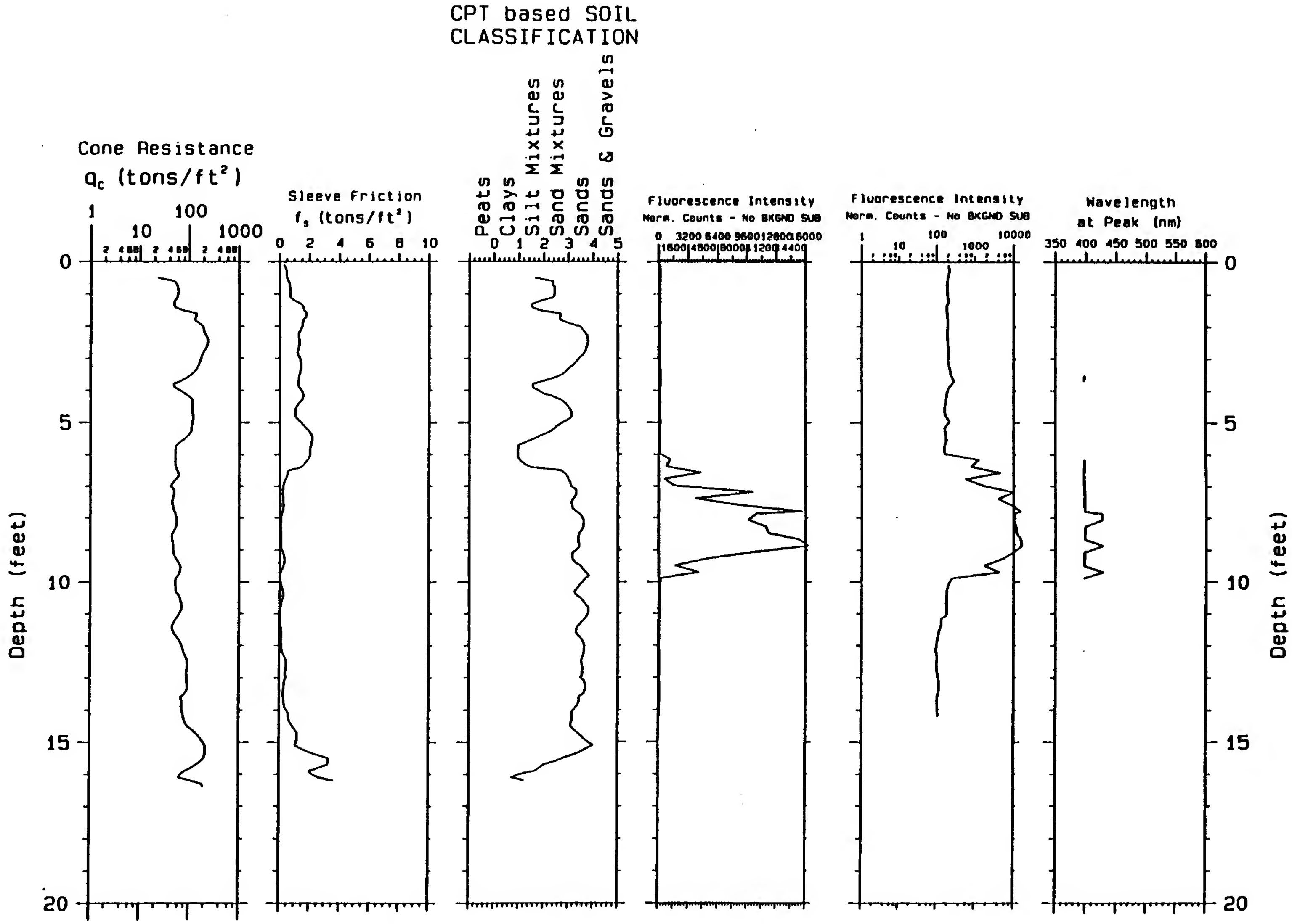
SCAPS Site Characterization and Analysis Penetrometer System

Project; Robins AFB

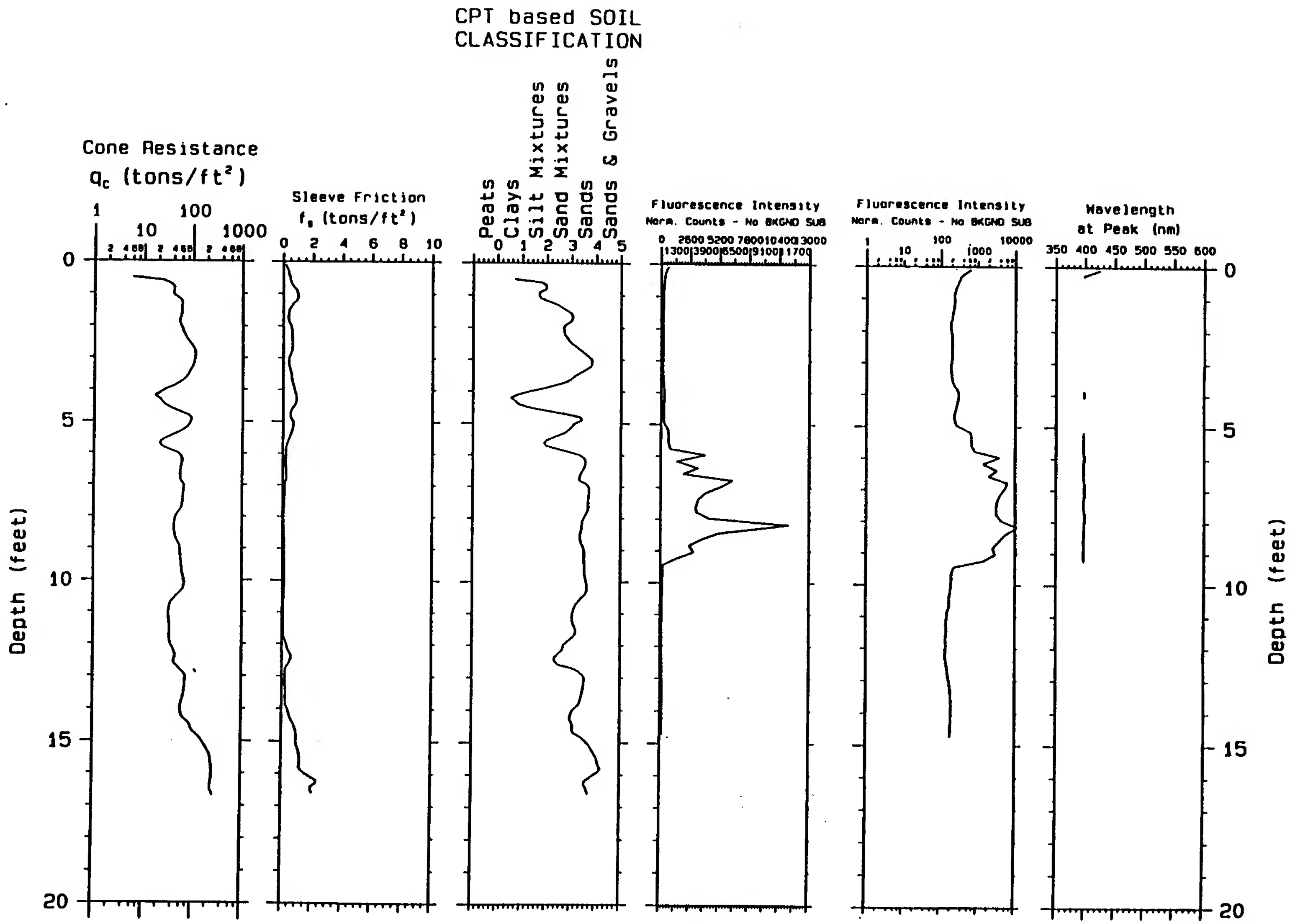
Probe Depth; 16.41

CPT; 29RBNLP

Probing date; 02-13-1995



Laser induced fluorescence of POL via fiber optics	Project; Robins AFB
U.S.Army Engineer District Kansas City Geotechnical Branch	Probe Depth; 16.51
SCAPS Site Characterization and Analysis Penetrometer System	CPT; 30RBNLP
Probing date; 02-13-1995	



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

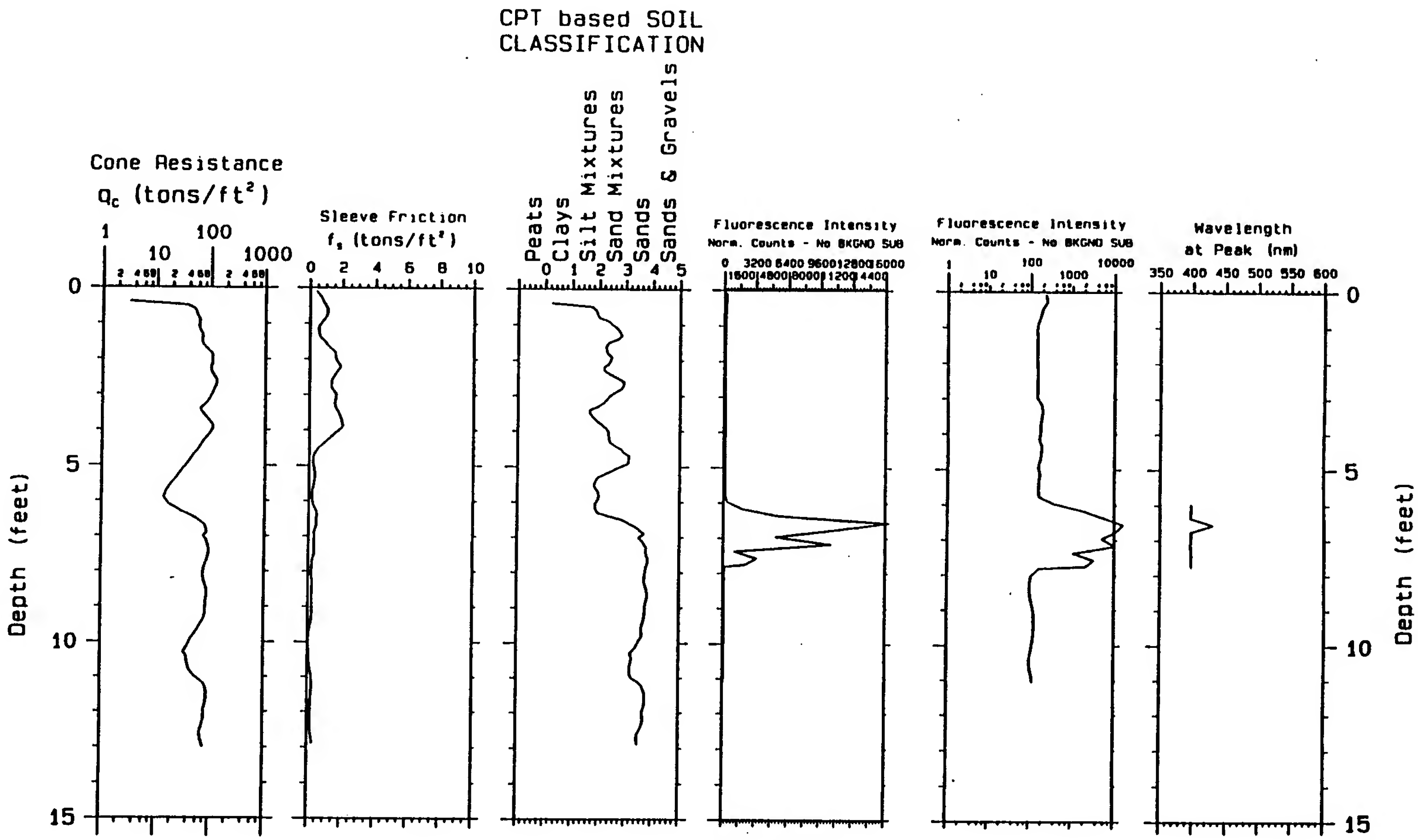
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.93

CPT; 32RBNL1

Probing date: 02-13-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

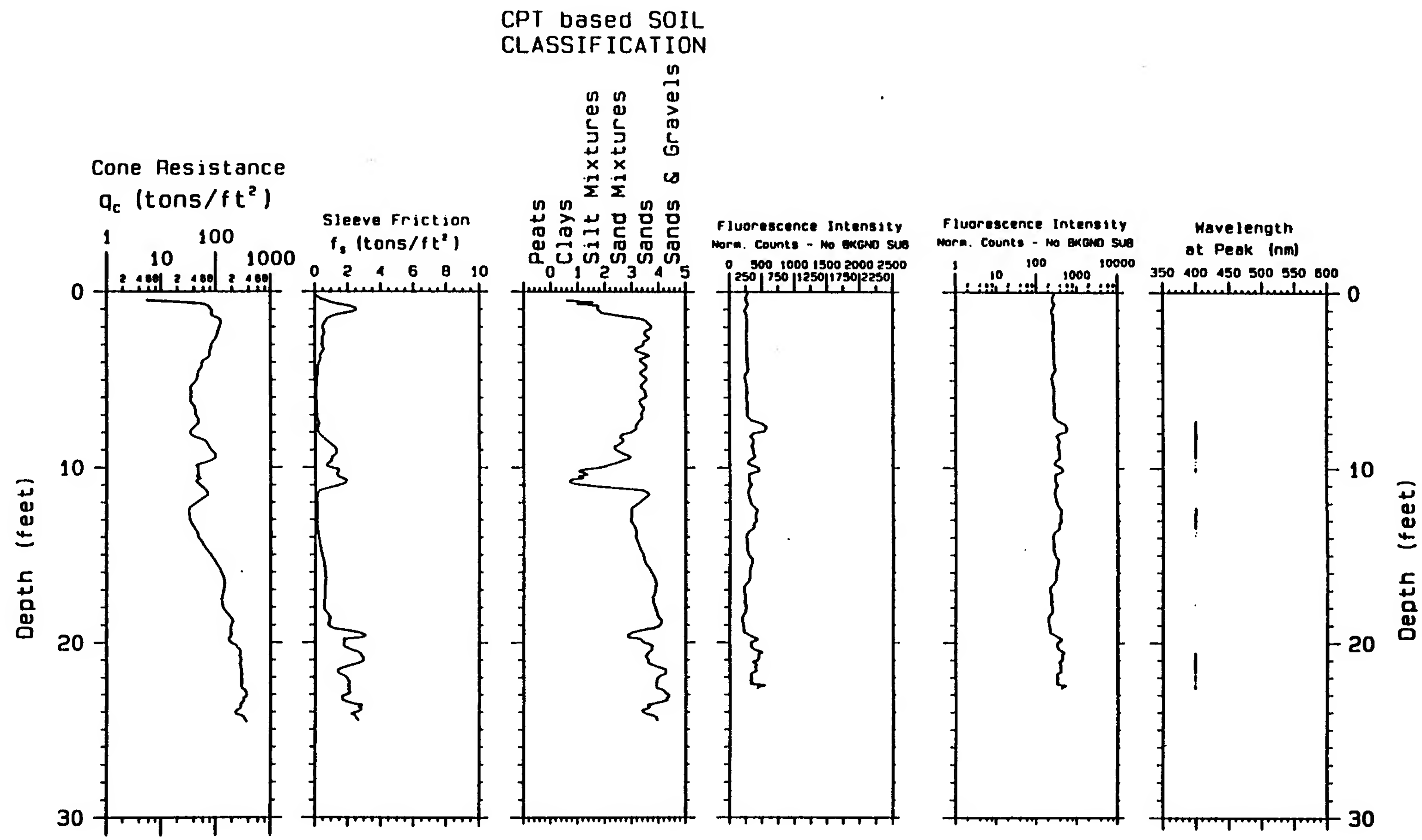
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 13.20

Probing date; 02-13-1995

CPT; 33RBNL1



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

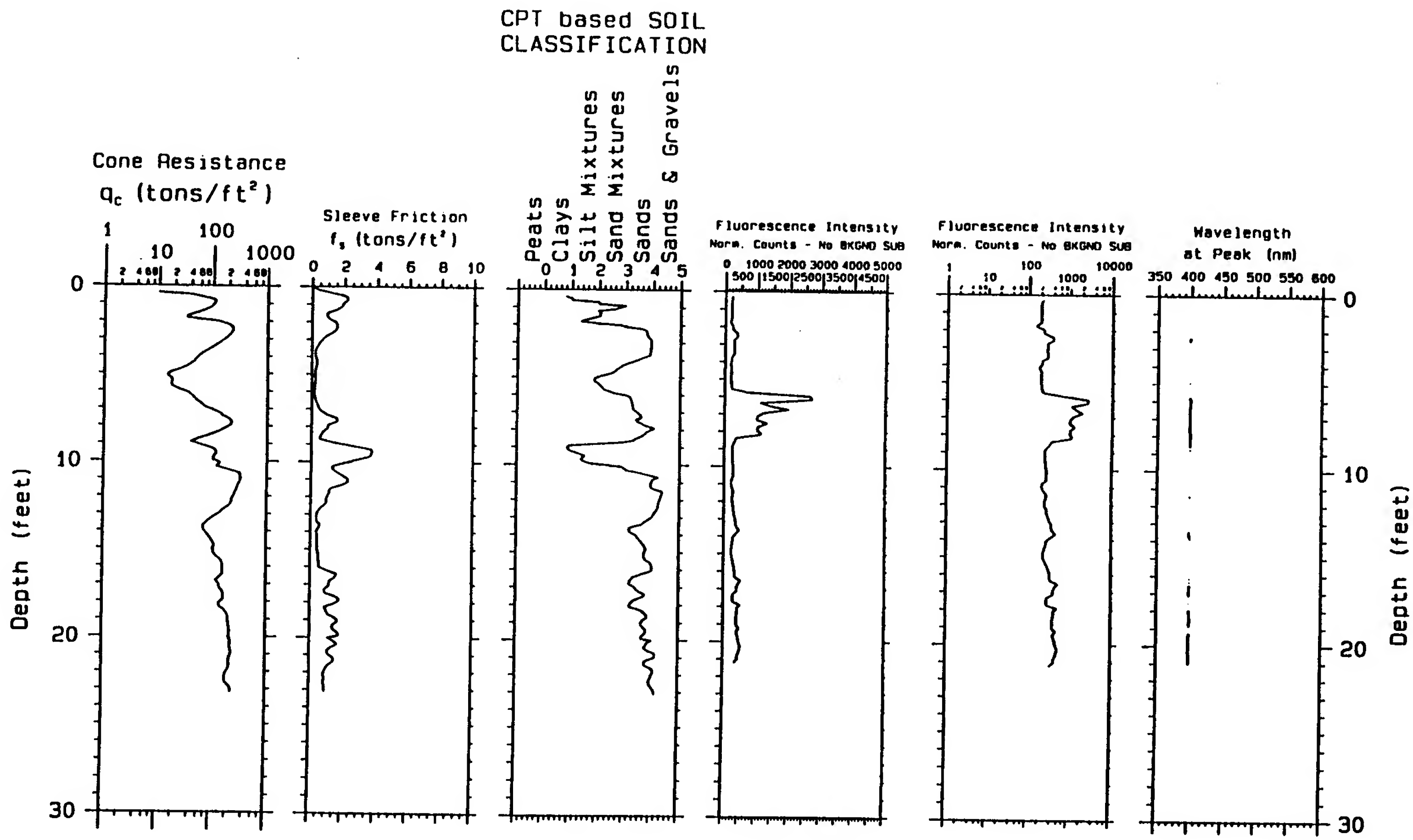
SCAPS Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 24.81

CPT; 37RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

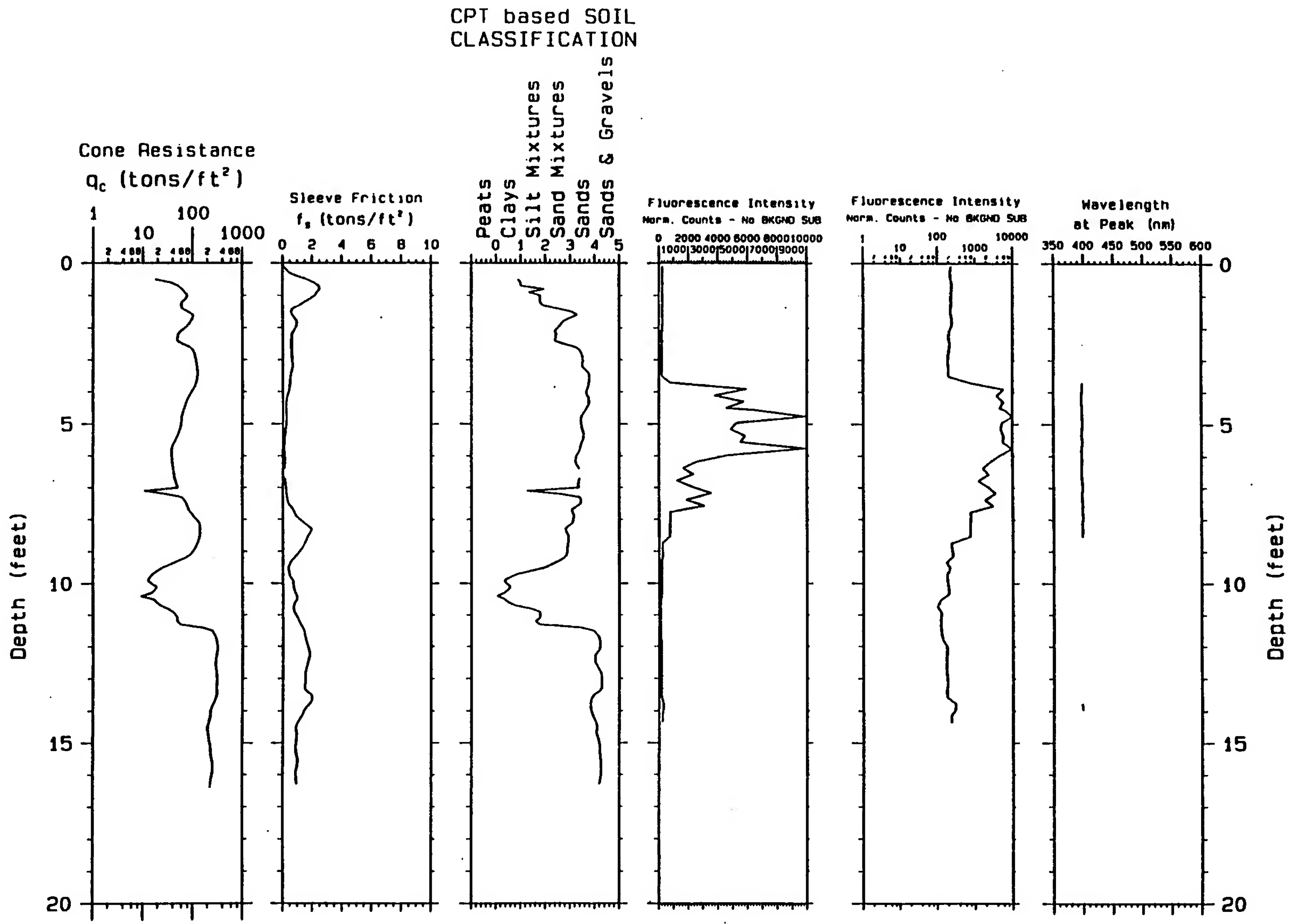
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 23.42

Probing date; 02-14-1995

CPT; 38RBNL2



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

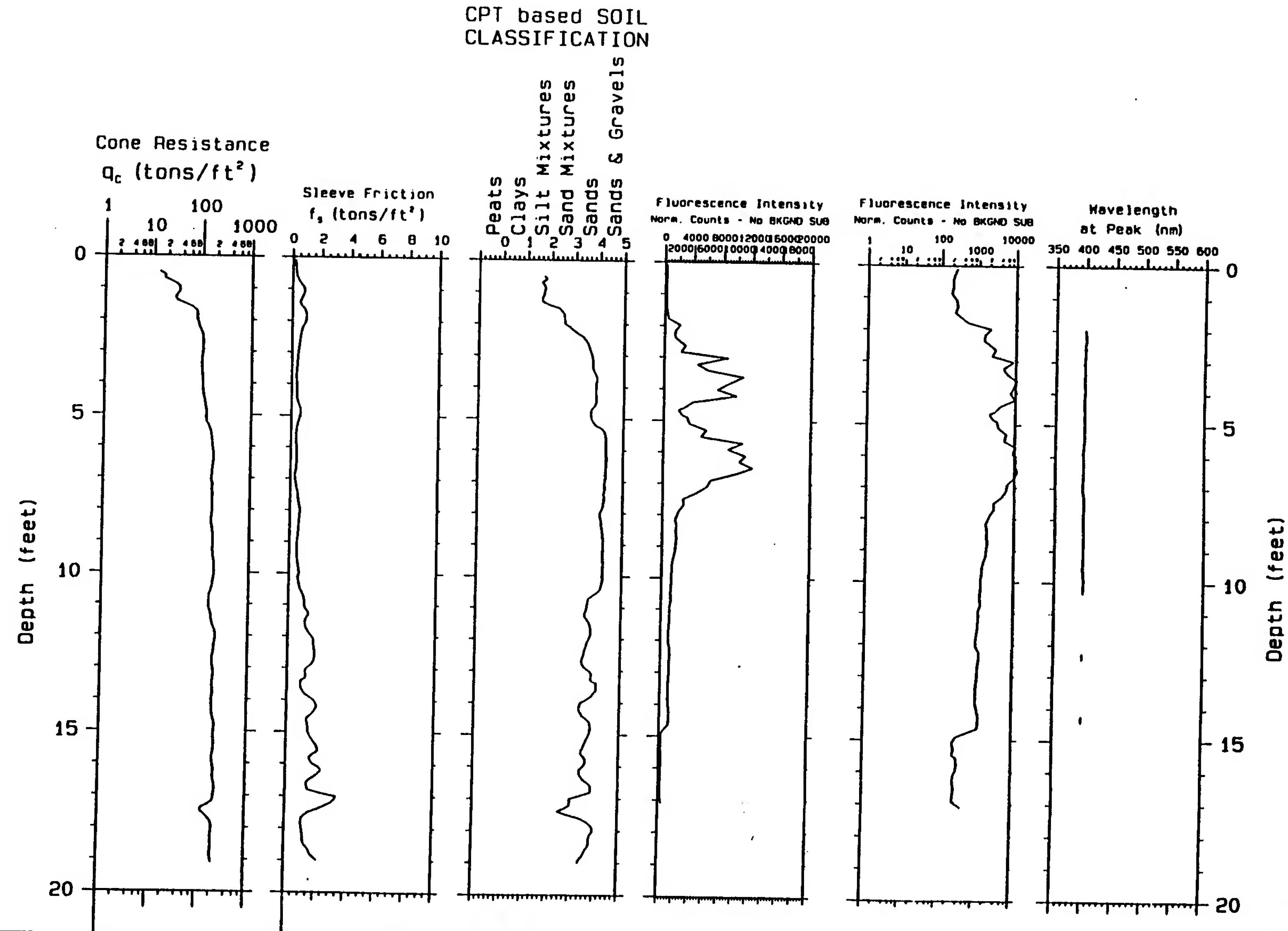
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.58

CPT; 39RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

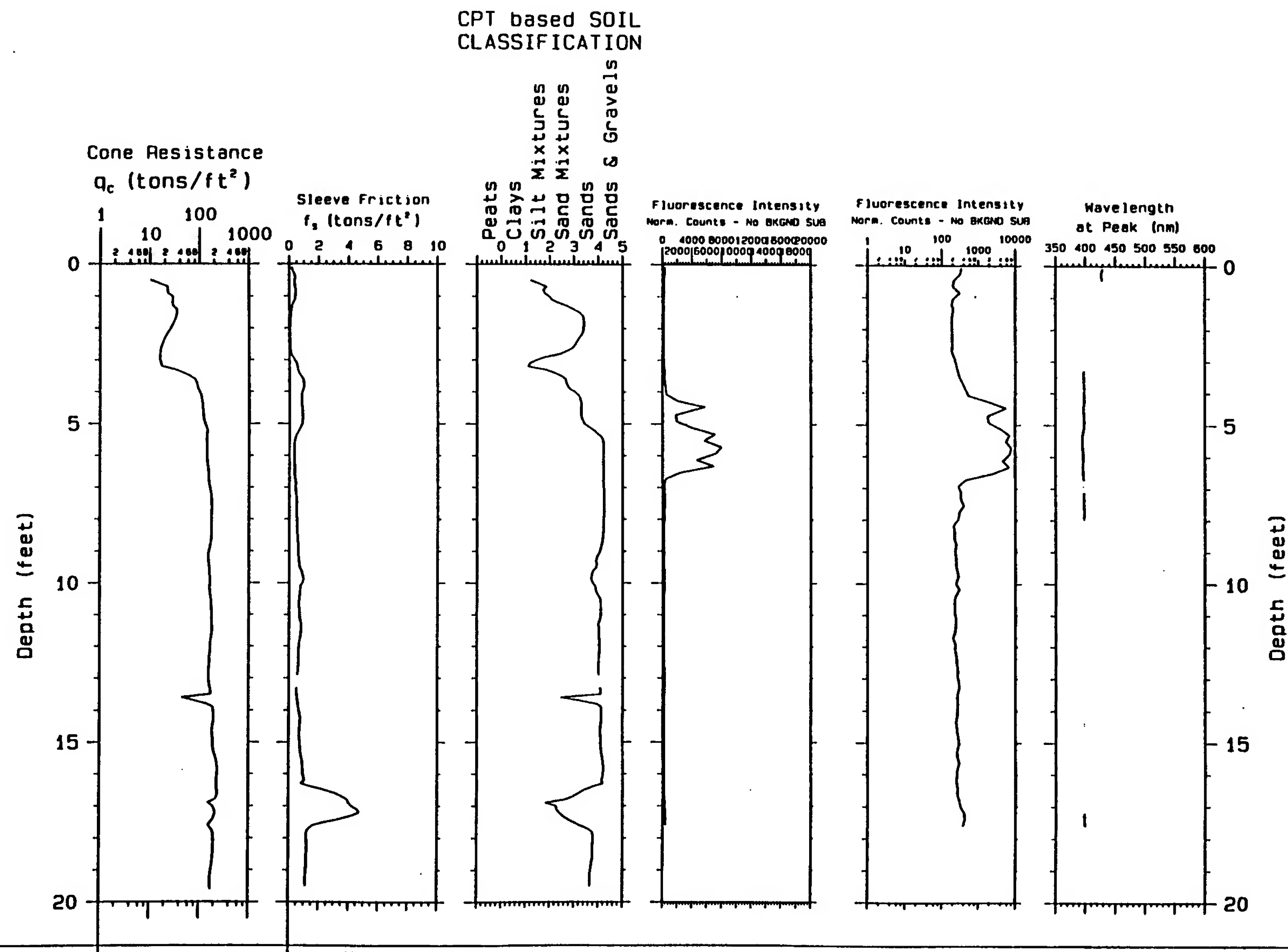
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 19.31

CPT; 40RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

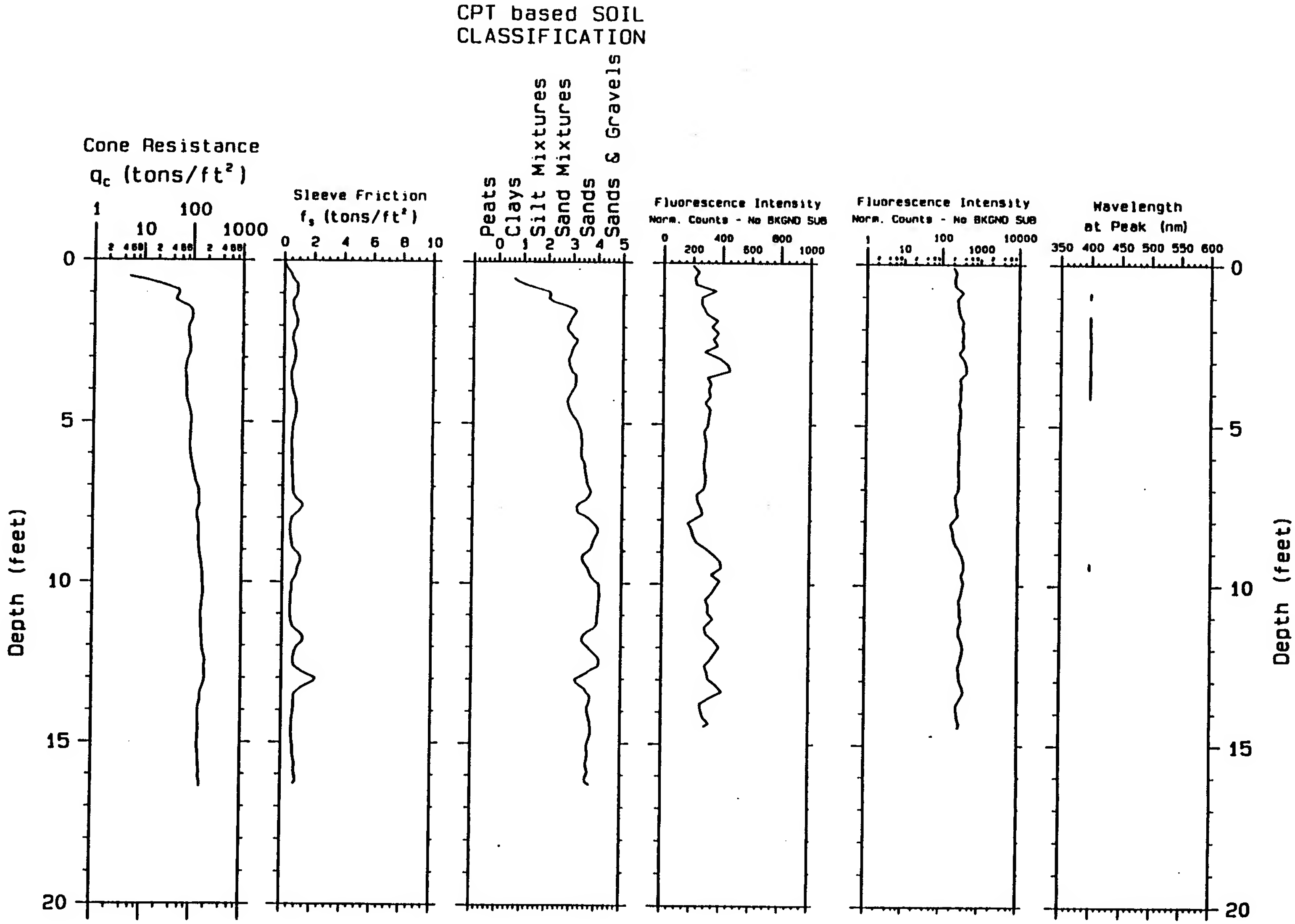
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 19.79

CPT; 41RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

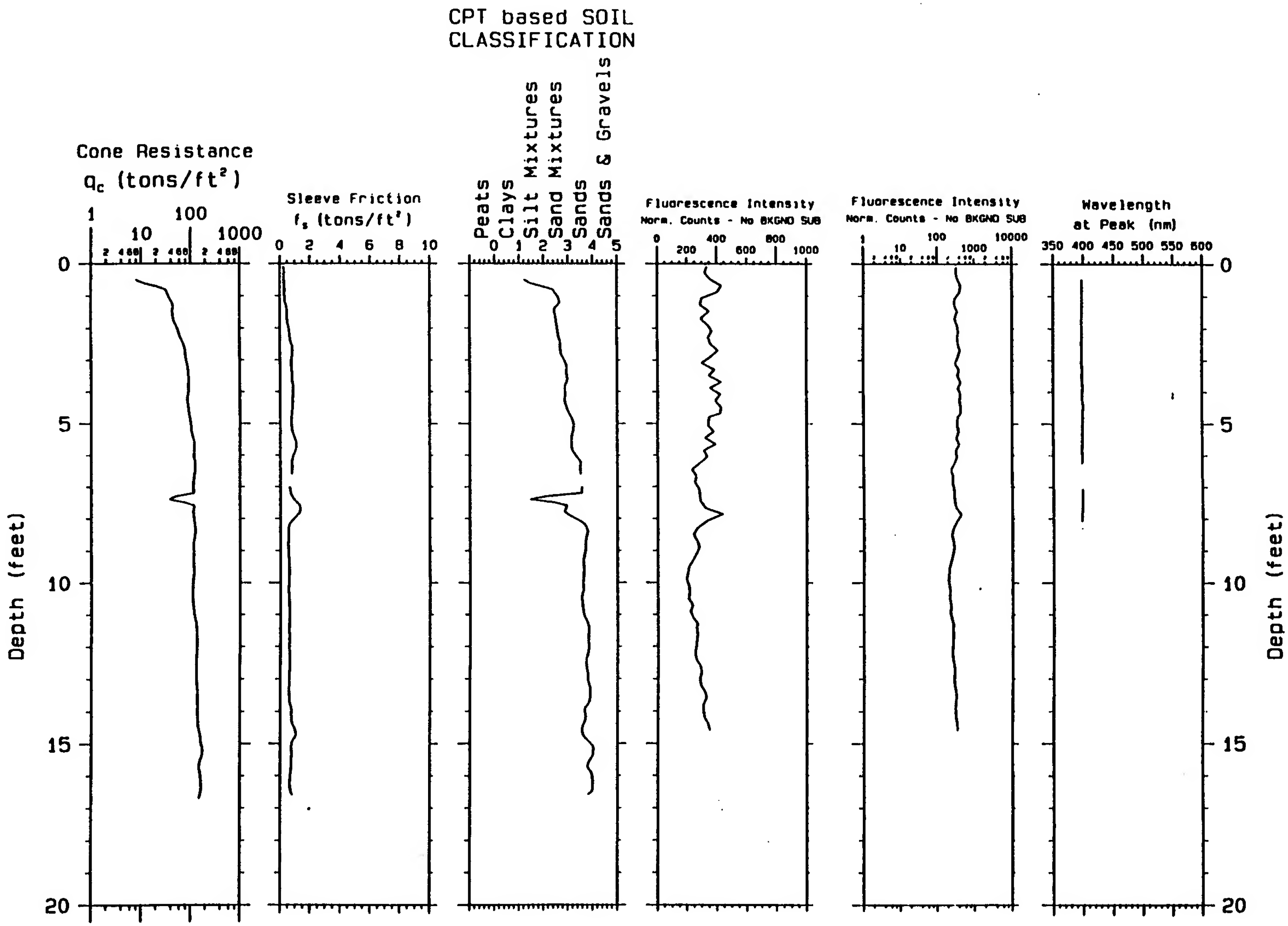
SCAPS Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.60

Probing date; 02-14-1995

CPT; 42RBNL2



Probing date: 02-14-1995

Laser induced
fluorescence
of POL via
fiber optics

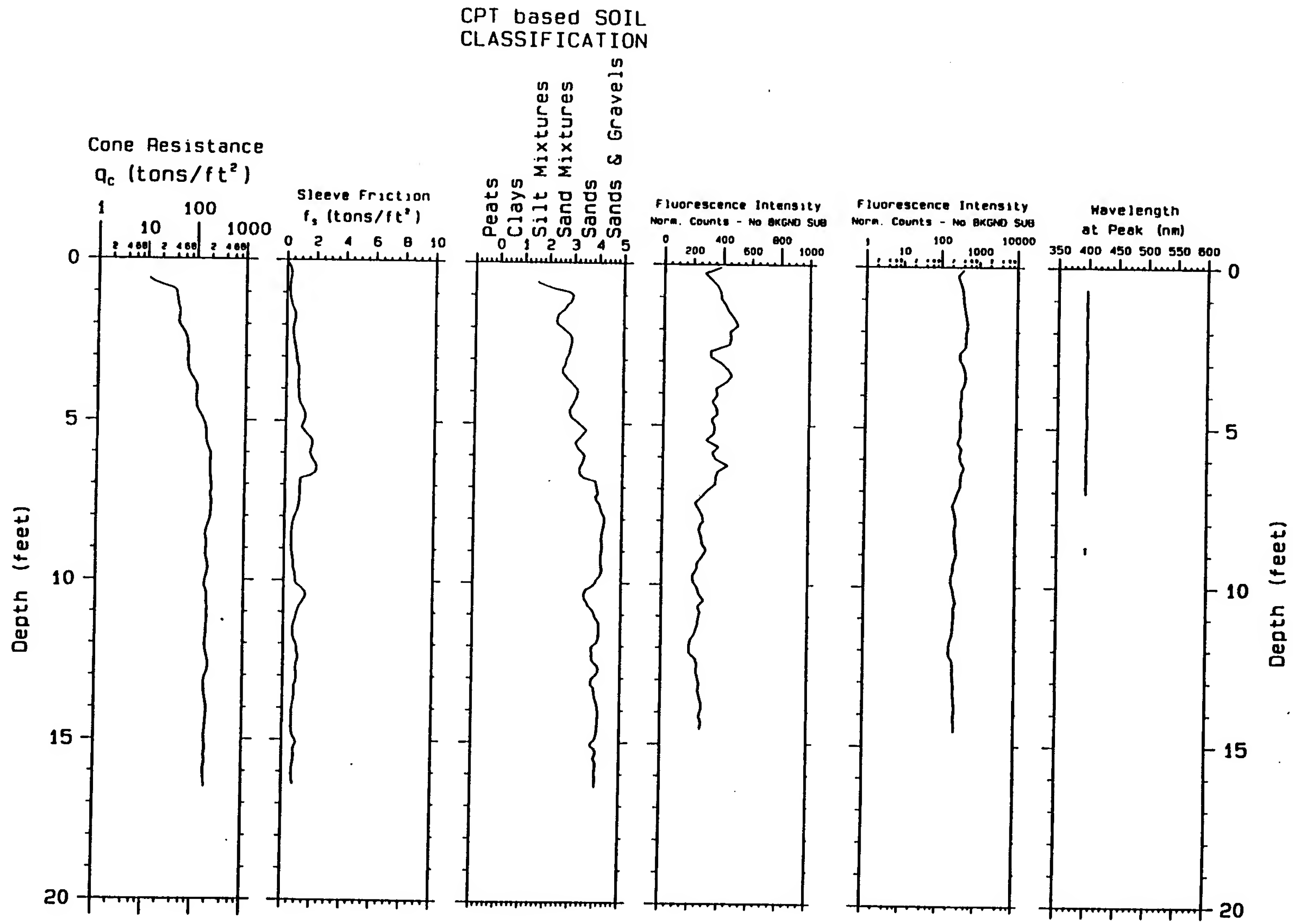
U.S.Army
Engineer
District
Kansas City
Geotechnical Branch

SCAPS

Site
Characterization
and Analysis
Penetrometer System

Project; Robins AFB
Probe Depth; 16.84

CPT; 43RBNL2



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

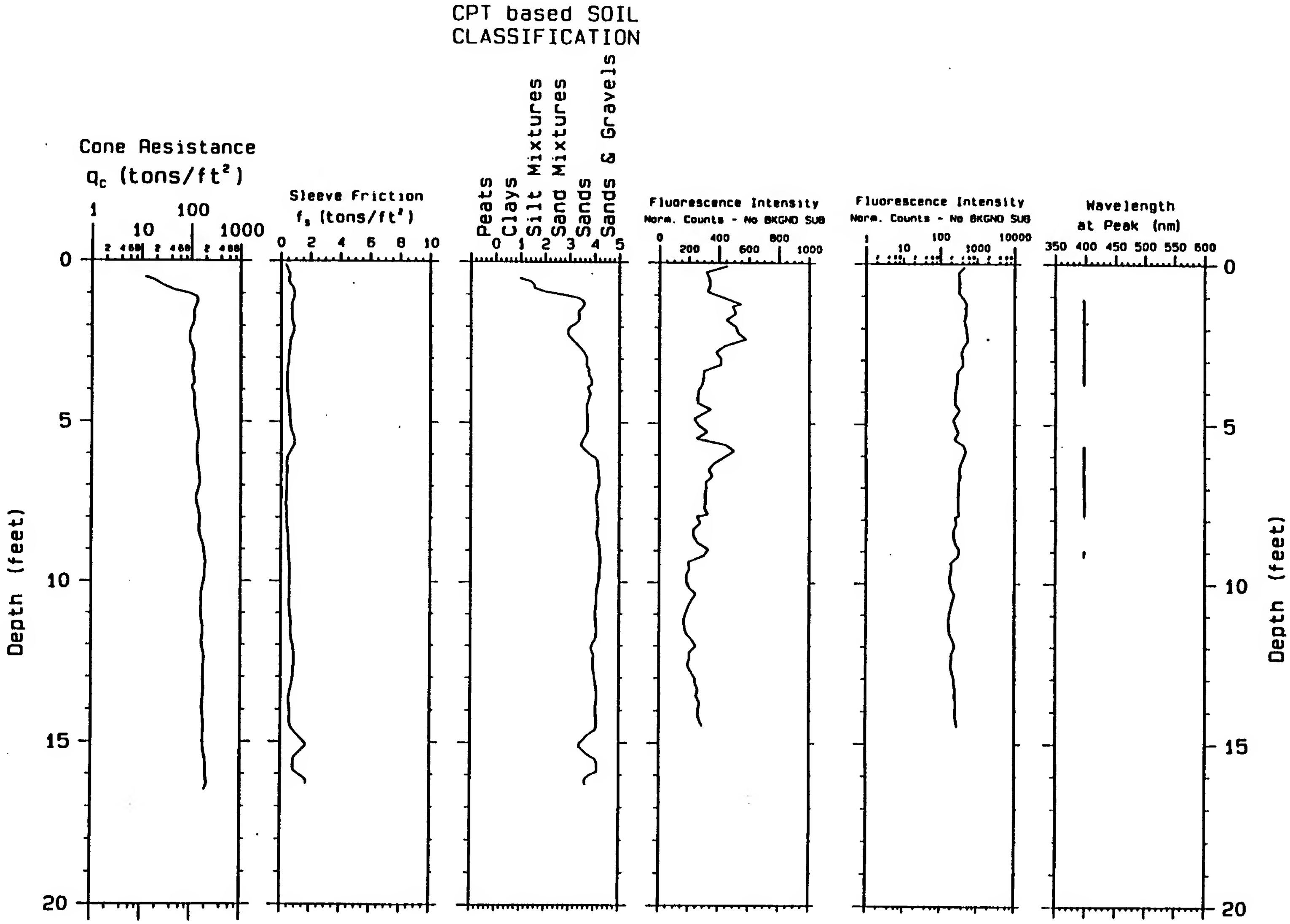
SCAPS Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.73

CPT; 44RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

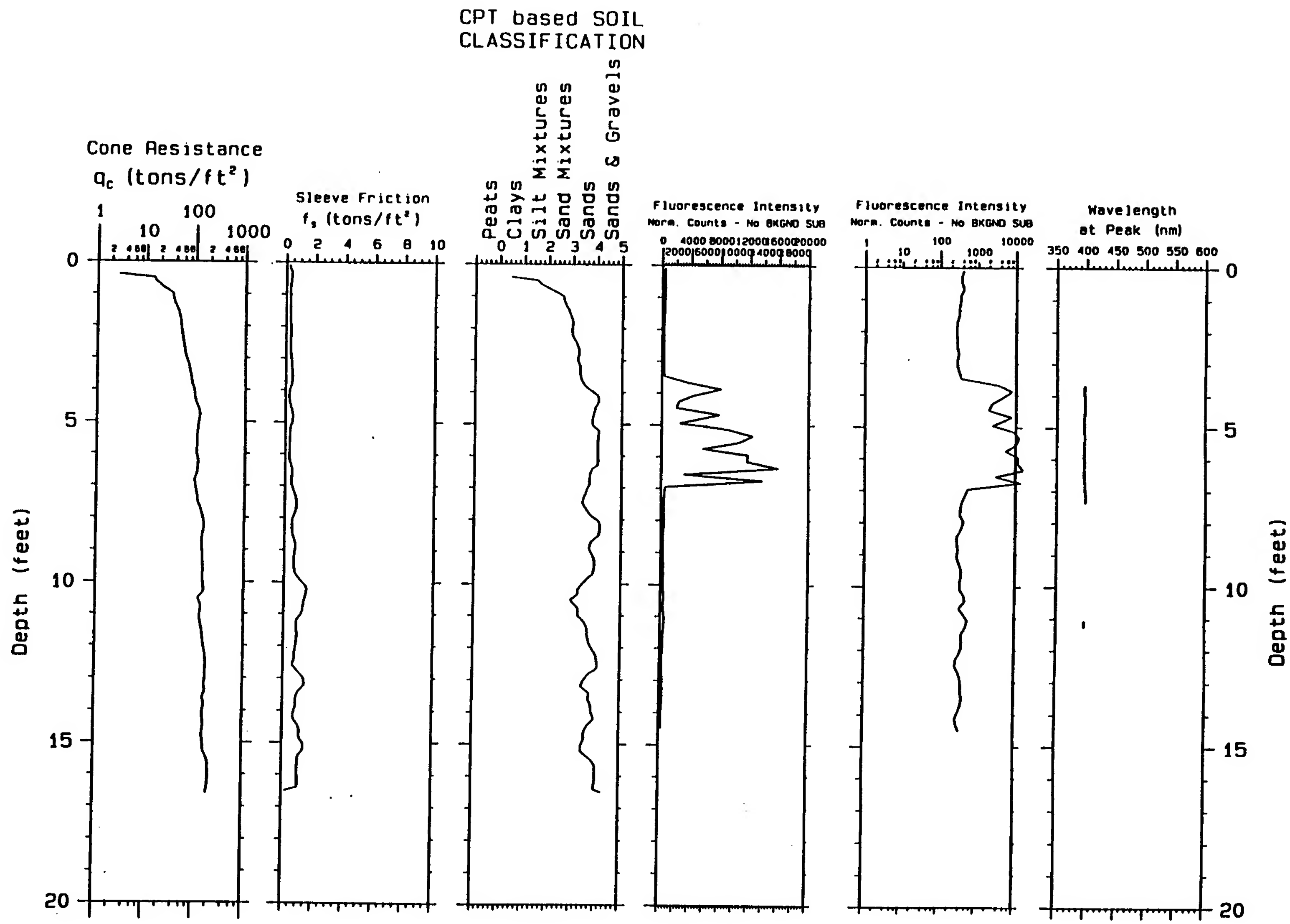
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.62

CPT; 45RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

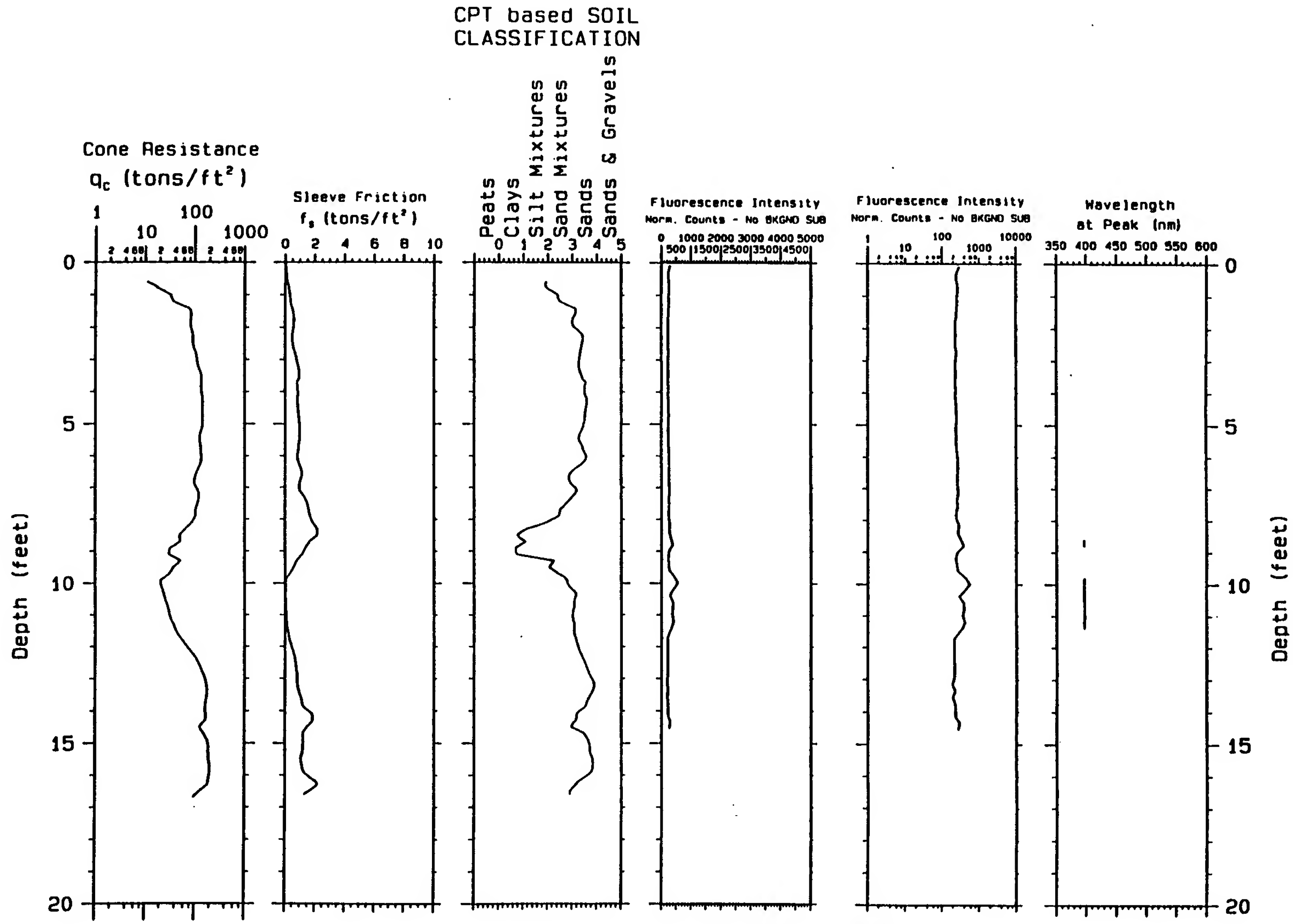
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.73

CPT; 46RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

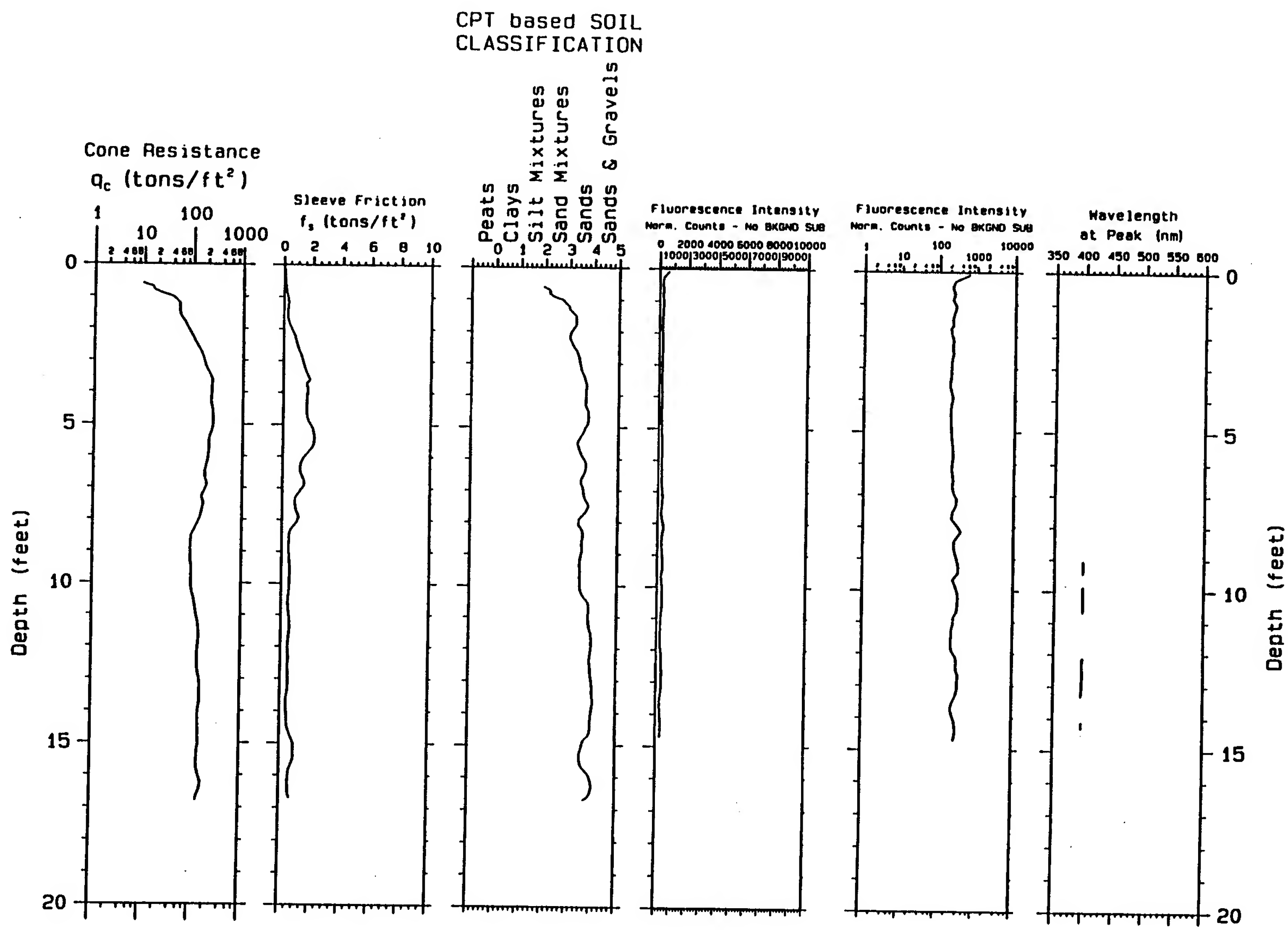
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.89

CPT; 47RBNL2

Probing date: 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

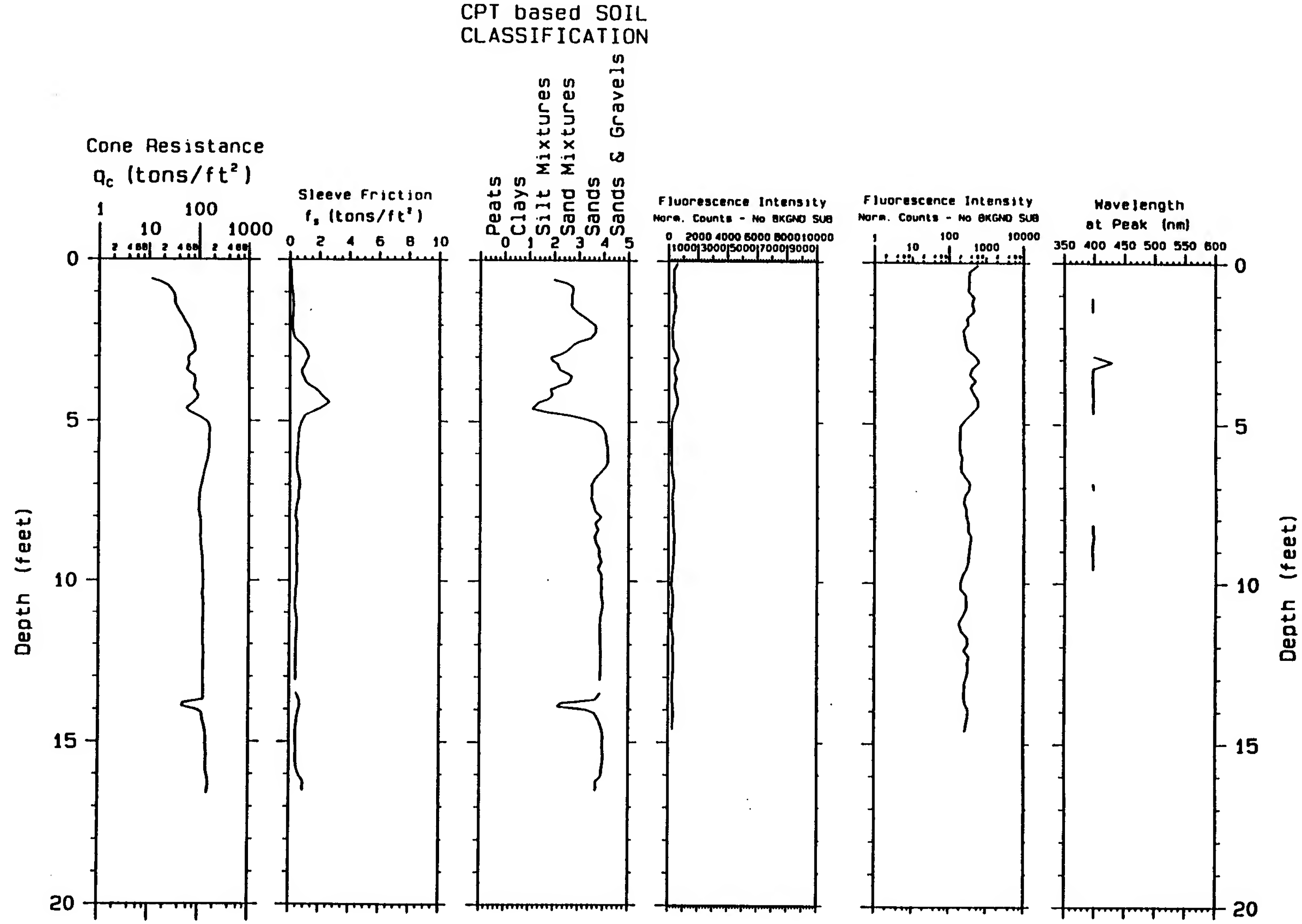
Site Characterization and Analysis Penetrometer System

Probing date; 02-14-1995

Project; Robins AFB

Probe Depth; 16.93

CPT; 48RBNL2



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

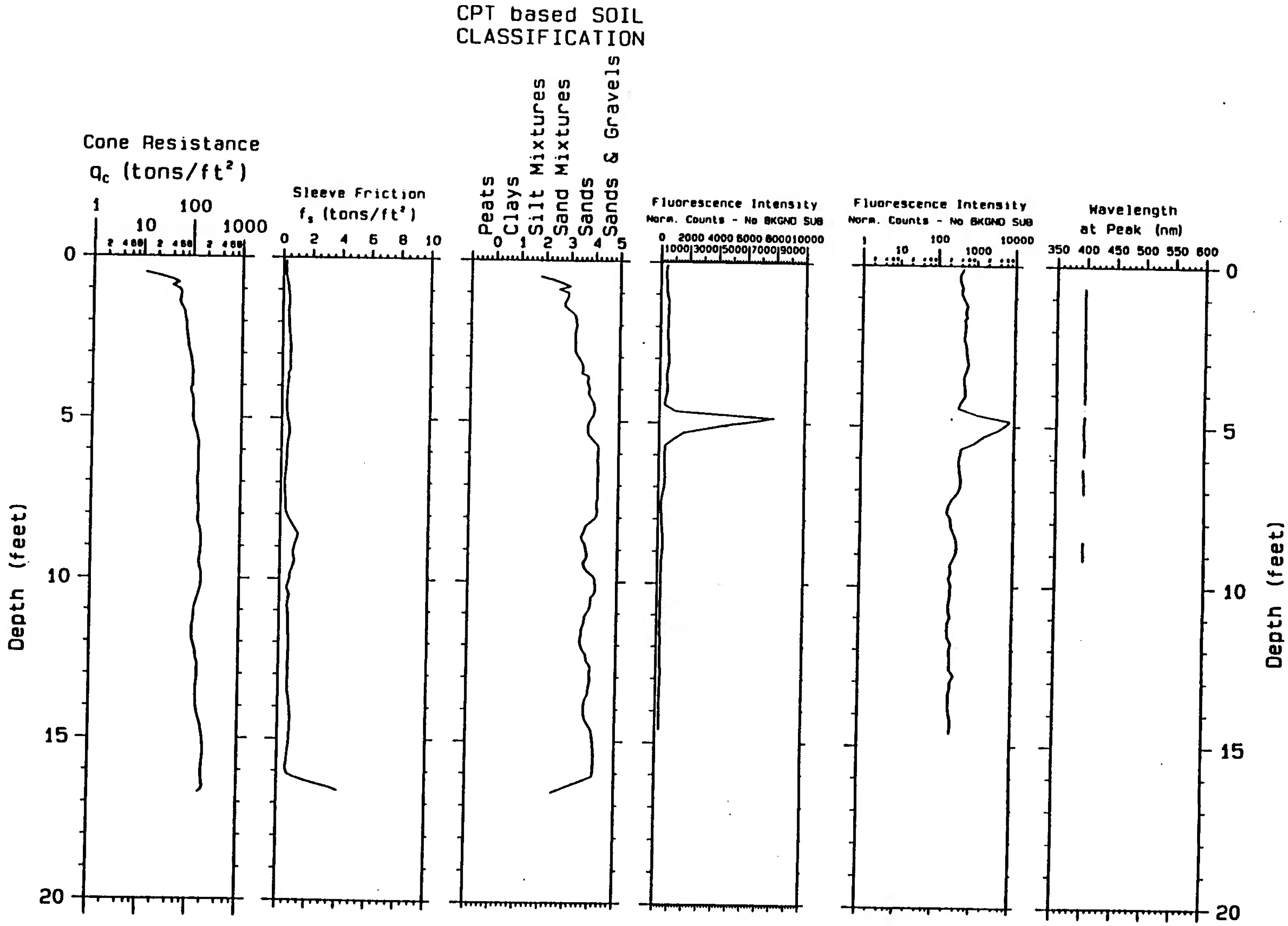
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.75

CPT; 49RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

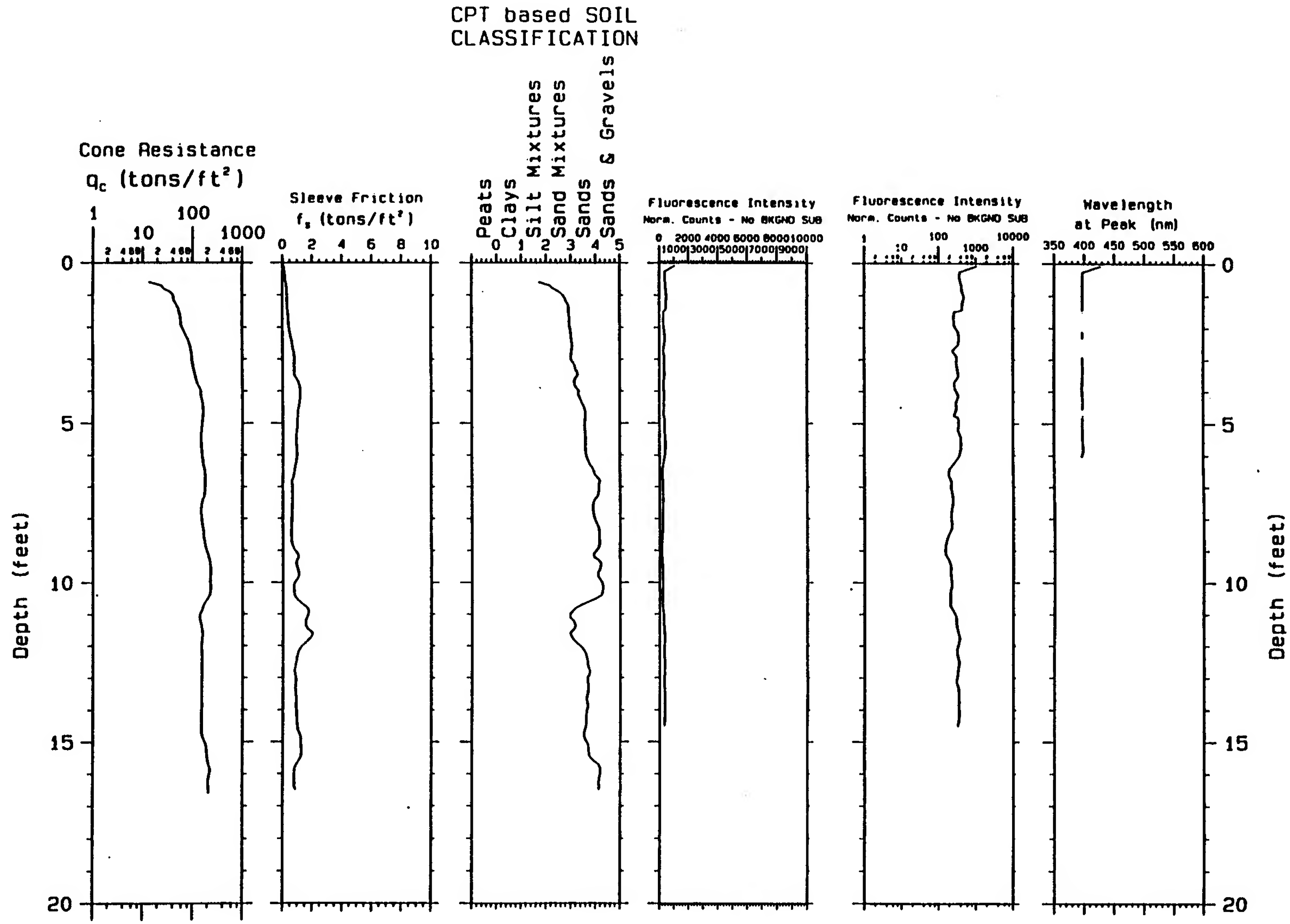
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.88

CPT; 50RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

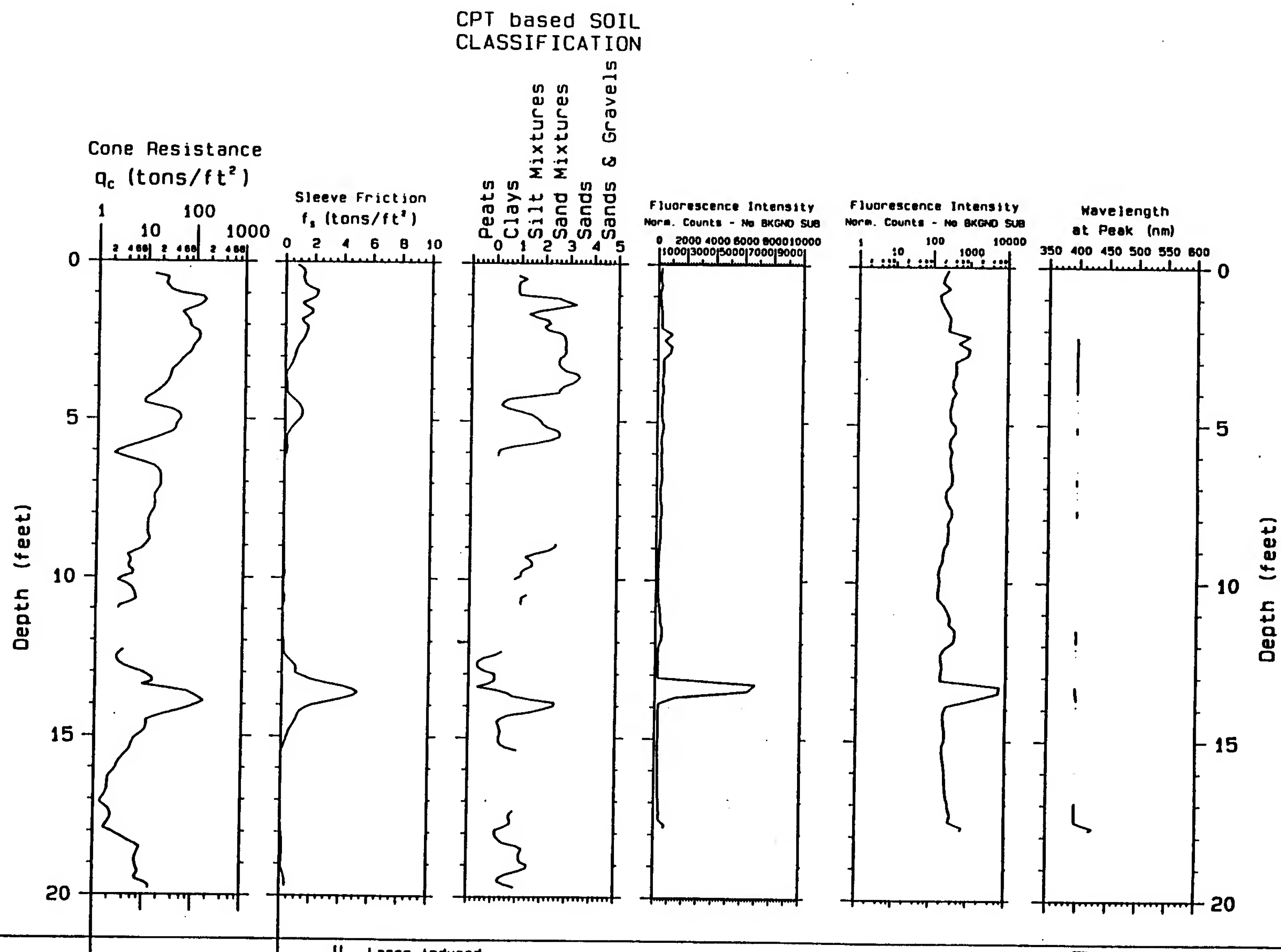
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 16.77

CPT; 51RBNL2

Probing date; 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

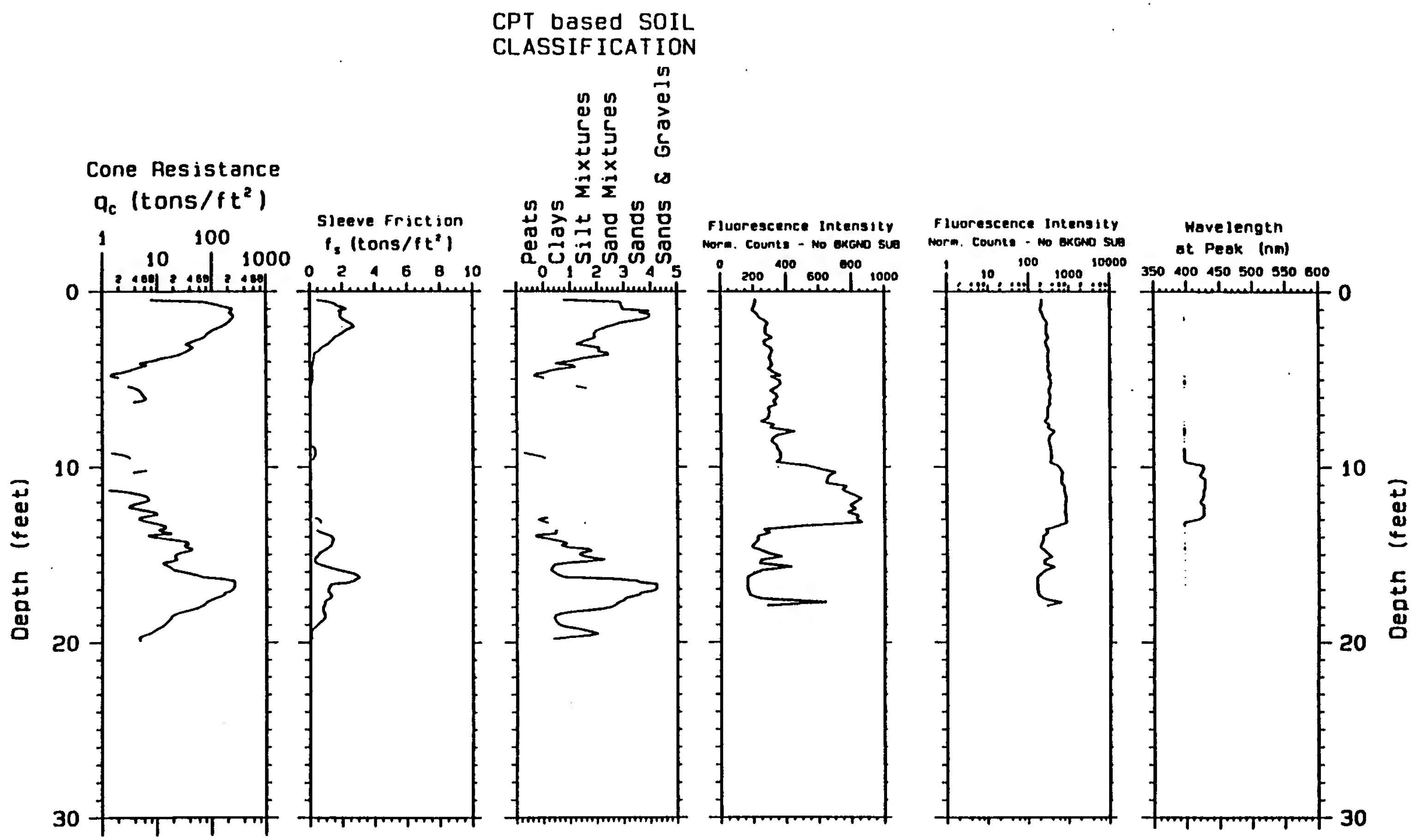
Site Characterization and Analysis Penetrometer System

Project; Robins AFB

Probe Depth; 19.94

CPT; 52RBNL2

Probing date: 02-14-1995



Laser induced fluorescence of POL via fiber optics

U.S. Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

Project; Robins AFB

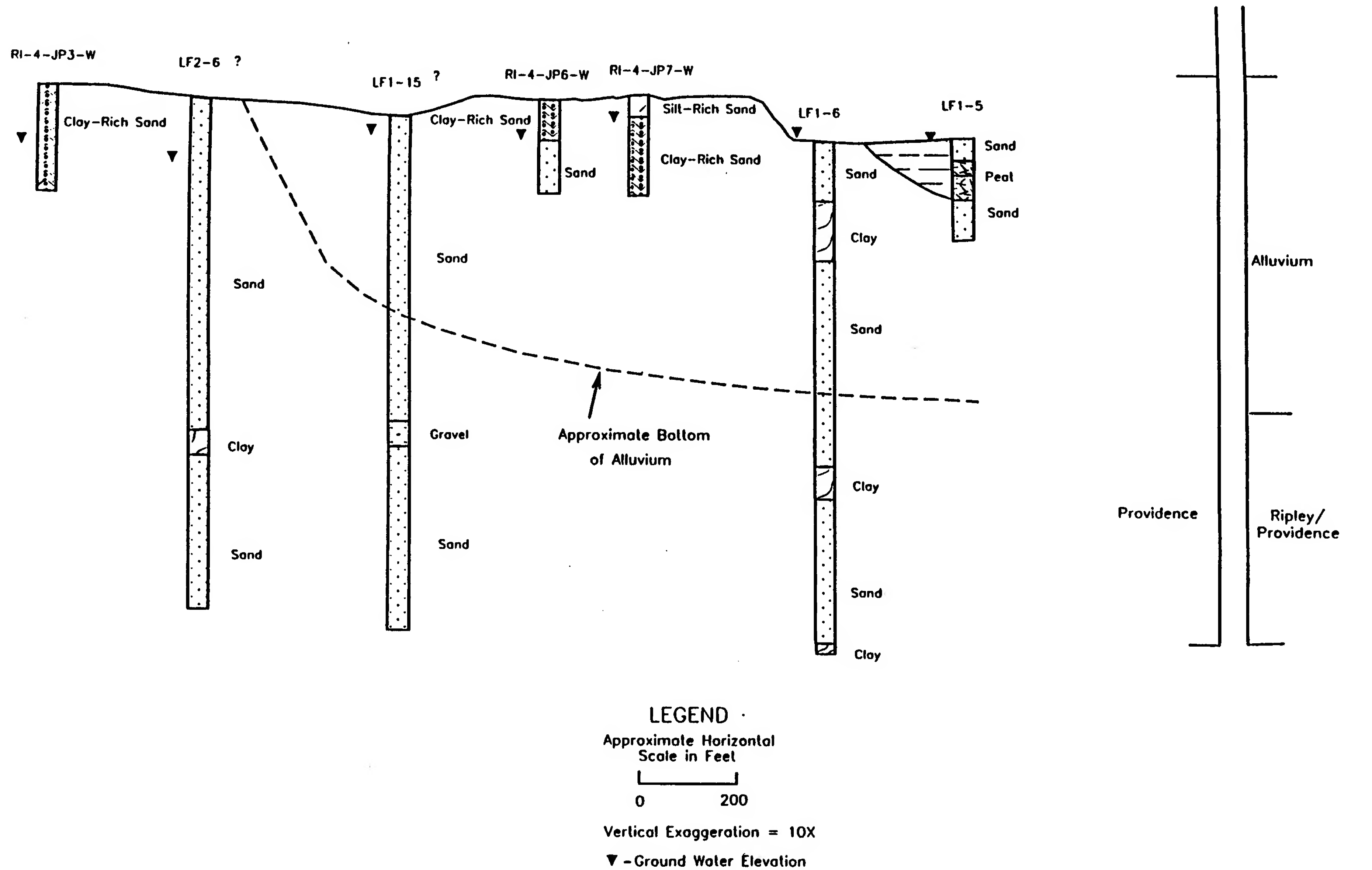
Probe Depth; 20.09

CPT; 53RBNL2

Probing date; 02-14-1995

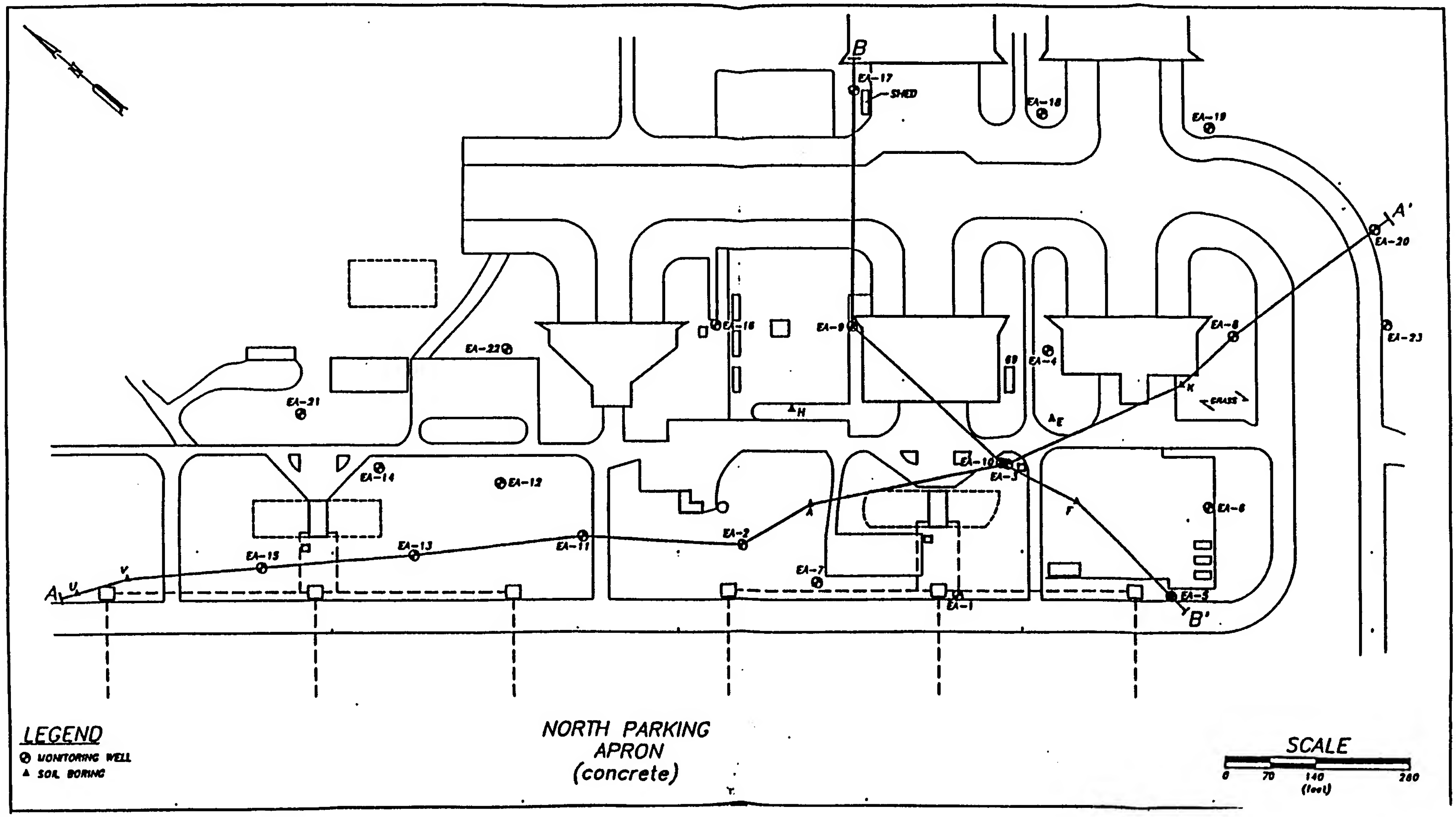
APPENDIX B

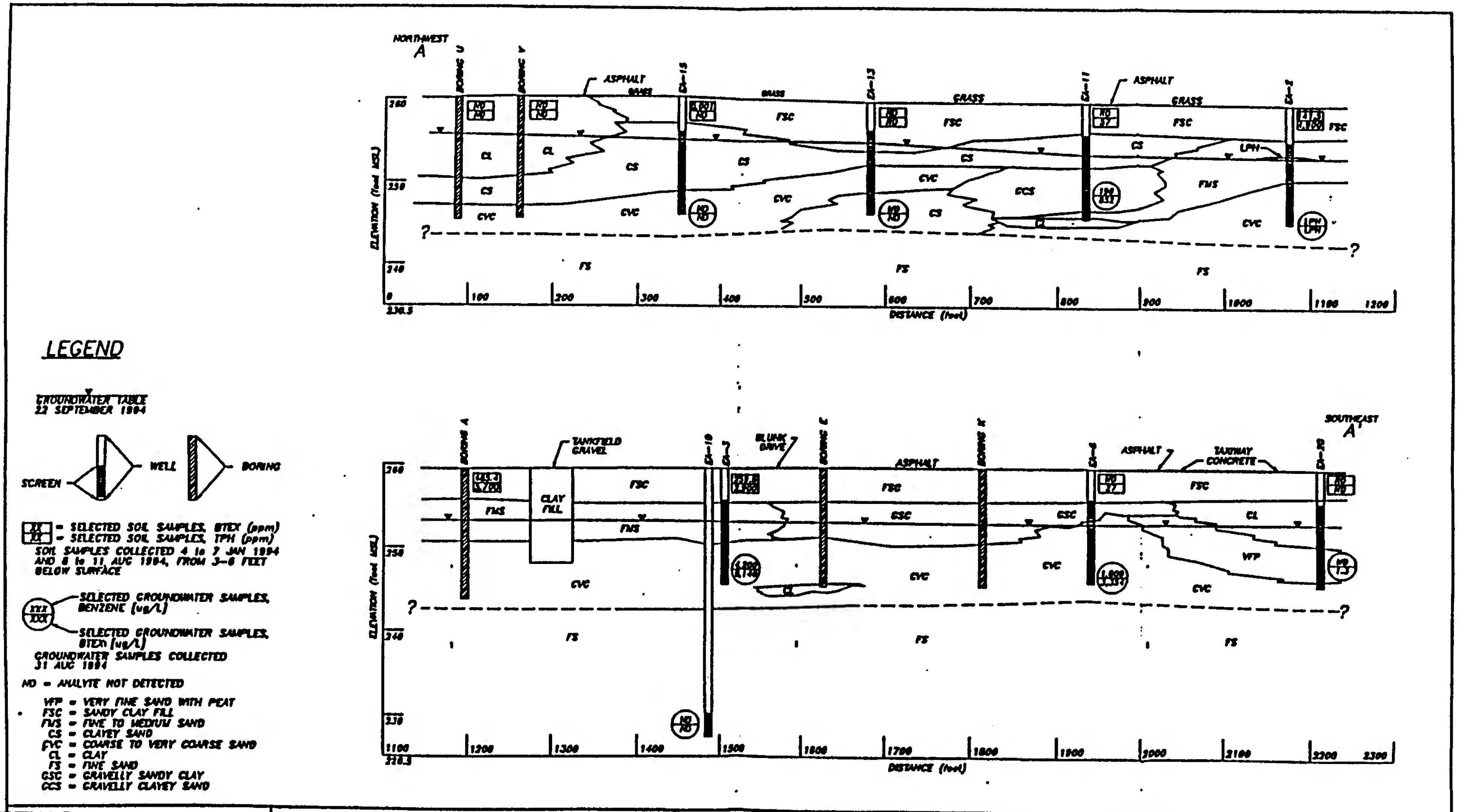
SITE CHARACTERIZATION DATA FOR SITE SS010


RI-4-JP3-W
LF2-6 ?
LF1-15 ?
RI-4-JP6-W
RI-4-JP7-W
LF1-6
LF1-5
Clay-Rich Sand
Sand
Clay
Sand
Clay-Rich Sand
Sand
Gravel
Sand
Sand
Silt-Rich Sand
Clay-Rich Sand
Sand
Clay
Sand
Clay
Sand
Clay
Sand
Peat
Sand
Approximate Bottom
of Alluvium
Alluvium
Providence
Ripley/
Providence
LEGEND
Approximate Horizontal
Scale in Feet
0
200
Vertical Exaggeration = 10X
▼ -Ground Water Elevation

APPENDIX C

SITE CHARACTERIZATION DATA FOR THE UST #70 AND #72 SITE


A
A'
B
B'
EA-1
EA-2
EA-3
EA-4
EA-5
EA-6
EA-7
EA-8
EA-9
EA-10
EA-11
EA-12
EA-13
EA-14
EA-15
EA-16
EA-17
EA-18
EA-19
EA-20
EA-21
EA-22
EA-23
SHED
GRASS
NORTH PARKING
APRON
(concrete)
LEGEND
MONITORING WELL
SOIL BORING
SCALE
0
70
140
(feet)
280


NORTHWEST
A
BORING U
BORING V
ASPHALT
EX-15
EX-13
EX-11
EX-2
GRASS
FSC
CL
CS
CVC
GCS
FMS
LPH
FS
ELEVATION (feet MSL)
DISTANCE (feet)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
BORING A
TANKFIELD GRAVEL
CLAY FILL
EX-10
EX-3
BLUNK DRIVE
BORING E
BORING X
EX-9
TAXIWAY CONCRETE
EX-20
SOUTHEAST
A'
GSC
VFP
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
LEGEND
GROUNDWATER TABLE
22 SEPTEMBER 1994
SCREEN
WELL
BORING
= SELECTED SOIL SAMPLES, BTEX (ppm)
= SELECTED SOIL SAMPLES, TPH (ppm)
SOIL SAMPLES COLLECTED 4 to 7 JAN 1994 AND 8 to 11 AUG 1994, FROM 3-6 FEET BELOW SURFACE
SELECTED GROUNDWATER SAMPLES, BENZENE (ug/L)
SELECTED GROUNDWATER SAMPLES, BTEX (ug/L)
GROUNDWATER SAMPLES COLLECTED 31 AUG 1994
ND = ANALYTE NOT DETECTED
VFP = VERY FINE SAND WITH PEAT
FSC = SANDY CLAY FILL
FMS = FINE TO MEDIUM SAND
CS = CLAYEY SAND
CVC = COARSE TO VERY COARSE SAND
CL = CLAY
FS = FINE SAND
GSC = GRAVELLY SANDY CLAY
GCS = GRAVELLY CLAYEY SAND

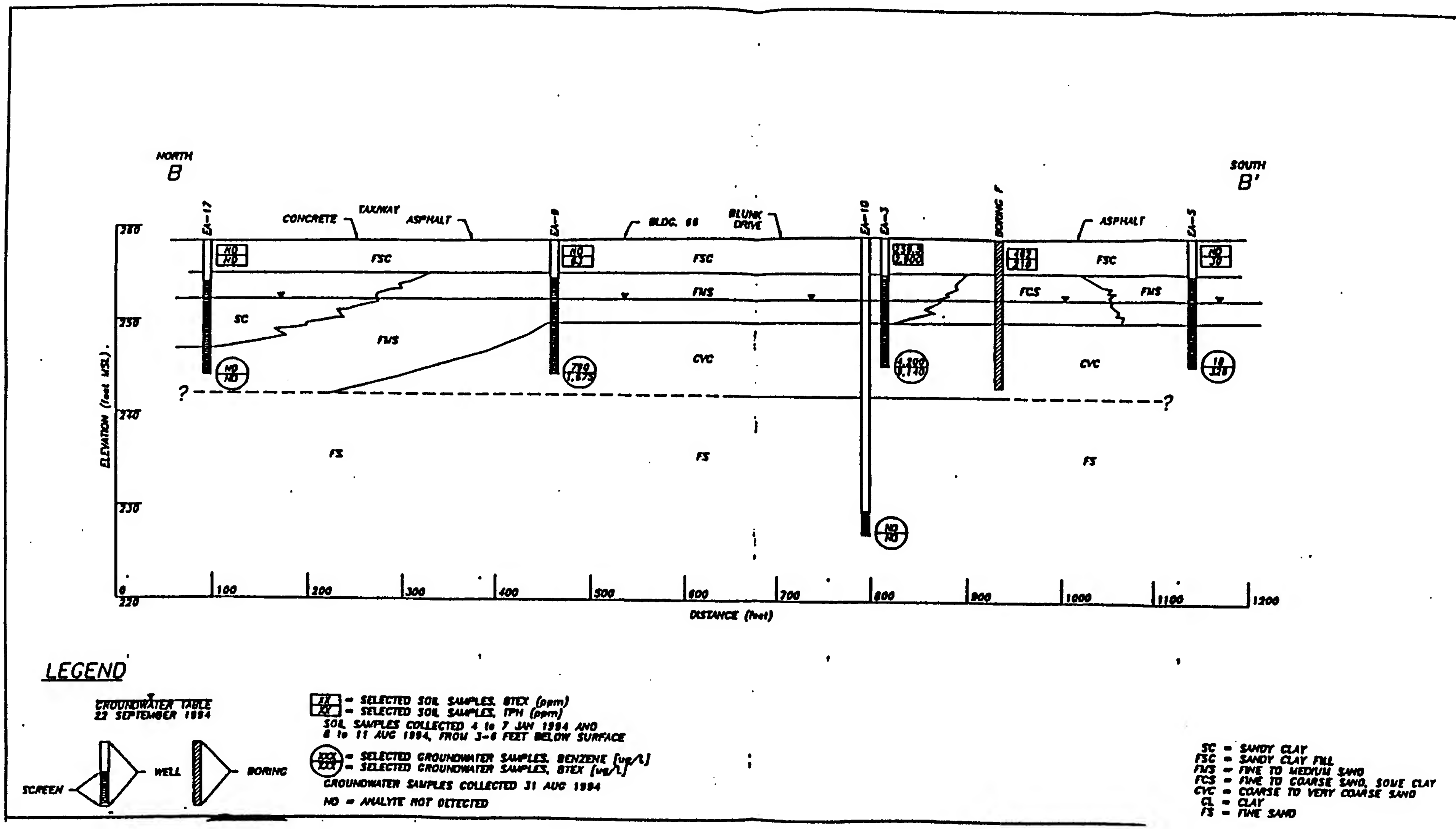

NORTH
B
SOUTH
B'
EA-17
EA-9
EA-10
EA-3
BORING F
EA-5
CONCRETE
TAXIWAY
ASPHALT
BLDG. 68
BLUNK DRIVE
ASPHALT
FSC
SC
FMS
CVC
FCS
FS
ELEVATION (feet MSL)
DISTANCE (feet)
LEGEND
GROUNDWATER TABLE 22 SEPTEMBER 1994
SCREEN
WELL
BORING
= SELECTED SOIL SAMPLES, BTEX (ppm)
= SELECTED SOIL SAMPLES, TPH (ppm)
SOIL SAMPLES COLLECTED 4 to 7 JAN 1994 AND 8 to 11 AUG 1994, FROM 3-6 FEET BELOW SURFACE
= SELECTED GROUNDWATER SAMPLES, BENZENE (ug/L)
= SELECTED GROUNDWATER SAMPLES, BTEX (ug/L)
GROUNDWATER SAMPLES COLLECTED 31 AUG 1994
ND = ANALYTE NOT DETECTED
SC = SANDY CLAY
FSC = SANDY CLAY FILL
FMS = FINE TO MEDIUM SAND
FCS = FINE TO COARSE SAND, SOME CLAY
CVC = COARSE TO VERY COARSE SAND
CL = CLAY
FS = FINE SAND

TABLE 6. SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA. 11206.69

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
11-Jan-94	EA-1	260.57	N/A	N/A	7.59	252.98	N/A	0.00	N/A
19-Jan-94	EA-1	260.57	N/A	N/A	7.48	253.09	N/A	0.00	N/A
07-Mar-94	EA-1	260.57	6.65	253.92	7.15	253.42	253.83	0.50	–
08-Mar-94	EA-1	260.57	6.73	253.84	7.19	253.38	253.75	0.46	0.8
8-9 Mar 94	^EA-1						SKIMMER BELT RECOVERY =		0.4
09-Mar-94	EA-1	260.57	6.76	253.81	6.79	253.78	253.80	0.03	–
10-Mar-94	EA-1	260.57	6.90	253.67	6.93	253.64	253.66	0.03	–
29-Mar-94	EA-1	260.57	6.80	253.77	7.03	253.54	253.73	0.23	0.2
31-Mar-94	EA-1	260.57	6.73	253.84	6.93	253.64	253.80	0.20	–
01-Apr-94	EA-1	260.57	6.68	253.89	6.97	253.60	253.83	0.29	0.2
07-Apr-94	EA-1	260.57	7.26	253.31	7.49	253.08	253.27	0.23	0.1
14-Apr-94	EA-1	260.57	7.48	253.09	7.58	252.99	253.07	0.10	0.05
21-Apr-94	EA-1	260.57	7.40	253.17	7.47	253.10	253.16	0.07	0.02
28-Apr-94	EA-1	260.57	7.67	252.90	7.69	252.88	252.90	0.02	0.01
04-May-94	EA-1	260.57	7.71	252.86	7.73	252.84	252.86	0.02	0.02
10-May-94	EA-1	260.57	N/A	N/A	7.82	252.75	N/A	0.00	N/A
26-May-94	EA-1	260.57	SHEEN	N/A	8.11	252.46	N/A	SHEEN	N/A
03-Jun-94	EA-1	260.57	N/A	N/A	8.28	252.29	N/A	0.00	N/A
08-Jun-94	EA-1	260.57	8.25	252.32	8.29	252.28	252.31	0.04	0.05
17-Jun-94	EA-1	260.57	N/A	N/A	8.18	252.39	N/A	0.00	N/A
20-Jun-94	EA-1	260.57	8.10	252.47	8.19	252.38	252.45	0.09	0.05
20-Jul-94	EA-1	260.57	6.94	253.63	7.34	253.23	253.55	0.40	0.10
26-Jul-94	EA-1	260.57	6.94	253.63	7.34	253.23	253.55	0.40	0.30
02-Aug-94	EA-1	260.57	6.96	253.61	7.43	253.14	253.52	0.47	0.35
09-Aug-94	EA-1	260.57	7.15	253.42	7.53	253.04	253.35	0.38	0.00
15-Aug-94	EA-1	260.57	7.41	253.16	7.81	252.76	253.08	0.40	0.00
18-Aug-94	EA-1	260.57	7.27	253.30	7.40	253.17	253.28	0.13	0.20
30-Aug-94	EA-1	260.57	7.33	253.24	7.58	252.99	253.19	0.25	0.00
08-Sep-94	EA-1	260.57	7.49	253.08	7.62	252.95	253.06	0.13	0.15
22-Sep-94	EA-1	260.57	N/A	N/A	7.37	253.20	N/A	0.00	N/A
30-Sep-94	EA-1	260.57	7.61	252.96	7.63	252.94	252.96	0.02	0.02
14-Oct-94	EA-1	260.57	N/A	N/A	7.11	253.46	N/A	0.00	N/A
25-Oct-94	EA-1	260.57	7.03	253.54	7.04	253.53	253.54	0.01	0.00
11-Jan-94	EA-2	259.22	5.97	253.25	7.11	252.11	253.03	1.14	1.7
19-Jan-94	EA-2	259.22	5.87	253.35	6.94	252.28	253.15	1.07	2.6
07-Mar-94	^EA-2	259.22	5.17	254.05	6.54	252.68	253.79	1.37	15.6
8-22 Mar 94	^EA-2						SKIMMER BELT RECOVERY =		79.4
29-Mar-94	^EA-2	259.22	5.22	254.00	6.62	252.60	253.73	1.40	–
29-31 Mar 94	^EA-2						SKIMMER BELT RECOVERY =		16.4
31-Mar-94	^EA-2		GAUGED FROM SKIMMER: LPH THICKNESS =					1.37	8.0
1-3 Apr 94	^EA-2						SKIMMER BELT RECOVERY =		32.8
4-6 Apr 94	^EA-2						SKIMMER BELT RECOVERY =		24.8
7-14 Apr 94	^EA-2						SKIMMER BELT RECOVERY =		25.6
14-Apr-94	EA-2	259.22	6.17	253.05	6.87	252.35	252.92	0.70	–
14-21 Apr 94	SKIMMER BELT WAS MOVED TO VW-8 FOR THIS WEEK								
21-Apr-94	EA-2	259.22	5.91	253.31	7.54	251.68	253.00	1.63	–
21-28 Apr 94	^EA-2						SKIMMER BELT RECOVERY =		47.4
28-Apr-94	^EA-2	259.22	6.14	253.08	7.66	251.56	252.79	1.52	–

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
28 Apr-4 May	^EA-2						SKIMMER BELT RECOVERY =		37.6
04-May-94	^EA-2	259.22	6.14	253.08	7.73	251.49	252.78	1.59	–
4-10 May-94	^EA-2						SKIMMER BELT RECOVERY =		52.2
10-May-94	^EA-2	259.22	6.23	252.99	7.81	251.41	252.69	1.58	–
10-26 May-94	^EA-2						SKIMMER BELT RECOVERY =		52.0
26-May-94	^EA-2	259.22	6.46	252.76	8.19	251.03	252.43	1.73	–
26 May-3 Jun	^EA-2						SKIMMER BELT RECOVERY =		51.2
03-Jun-94	^EA-2	259.22	6.63	252.59	8.24	250.98	252.28	1.61	–
3-8 Jun 94	^EA-2						SKIMMER BELT RECOVERY =		51.0
08-Jun-94	^EA-2.	259.22	6.63	252.59	8.20	251.02	252.29	1.57	–
8-17 Jun 94	^EA-2						SKIMMER BELT RECOVERY =		49.2
17-Jun-94	^EA-2	259.22	6.61	252.61	8.15	251.07	252.32	1.54	–
17-20 Jun 94	^EA-2						SKIMMER BELT RECOVERY =		49.0
20-Jun-94	^EA-2	259.22	6.57	252.65	7.91	251.31	252.40	1.34	–
20-22 Jun 94	^EA-2						SKIMMER BELT RECOVERY =		31.0
22-Jun-94	^EA-2	259.22	6.62	252.60	7.94	251.28	252.35	1.32	–
22-27 Jun 94	^EA-2						SKIMMER BELT RECOVERY =		50.4
27-29 Jun 94	^EA-2						SKIMMER BELT RECOVERY =		0.0
29-Jun-94	^EA-2	259.22	6.54	252.68	7.99	251.23	252.40	1.45	–
29 Jun-1 Jul	^EA-2						SKIMMER BELT RECOVERY =		23.2
1-5 Jul 94	^EA-2						SKIMMER BELT RECOVERY =		44.8
5-12 Jul 94	^EA-2						SKIMMER BELT RECOVERY =		0.0
12-Jul-94	^EA-2	259.22	5.32	253.90	6.33	252.89	253.71	1.01	–
12-18 Jul 94	^EA-2						SKIMMER BELT RECOVERY =		3.6
18-Jul-94	^EA-2	259.22	N/A	N/A	5.96	253.26	N/A	0.00	–
18-20 Jul 94	^EA-2						SKIMMER BELT RECOVERY =		0.0
20-Jul-94	^EA-2	259.22	N/A	N/A	5.98	253.24	N/A	0.00	–
18-26 Jul 94	^EA-2	SKIMMER BELT OFF							
26-Jul-94	^EA-2	259.22	5.63	253.59	6.80	252.42	253.37	1.17	0.0
26 Jul- 2 Aug	^EA-2						SKIMMER BELT RECOVERY =		27.8
02-Aug-94	^EA-2	259.22	5.94	253.28	6.00	253.22	253.27	0.06	–
2-9 Aug 94	^EA-2						SKIMMER BELT RECOVERY =		4.2
09-Aug-94	^EA-2	259.22	6.13	253.09	6.15	253.07	253.09	0.02	–
9-16 Aug 94	^EA-2						SKIMMER BELT RECOVERY =		7.0
16-Aug-94	^EA-2	259.22	6.21	253.01	6.89	252.33	252.88	0.68	–
16-18 Aug 94	^EA-2						SKIMMER BELT RECOVERY =		6.6
18-Aug-94	^EA-2	259.22	6.02	253.20	6.45	252.77	253.12	0.43	–
18-30 Aug 94	^EA-2						SKIMMER BELT RECOVERY =		51.2
30-Aug-94	^EA-2	259.22	5.97	253.25	7.37	251.85	252.98	1.40	–
30 Aug-8 Sep	^EA-2						SKIMMER BELT RECOVERY =		52.2
08-Sep-94	^EA-2	259.22	6.11	253.11	7.46	251.76	252.85	1.35	–
8-22 Sep 94	^EA-2						SKIMMER BELT RECOVERY =		50.0
22-Sep-94	^EA-2	259.22	5.94	253.28	7.30	251.92	253.02	1.36	–
22-30 Sep 94	^EA-2						SKIMMER BELT RECOVERY =		53.0
30-Sep-94	^EA-2	259.22	6.11	253.11	7.66	251.56	252.82	1.55	–
9/30 - 10/14	^EA-2						SKIMMER BELT RECOVERY =		44.4
14-Oct-94	^EA-2	259.22	5.73	253.49	7.00	252.22	253.25	1.27	–
14-25 Oct 94	^EA-2						SKIMMER BELT RECOVERY =		51.4
25-Oct-94	^EA-2	259.22	5.66	253.56	7.09	252.13	253.29	1.43	–

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
11-Jan-94	EA-3	260.11	N/A	N/A	7.36	252.75	N/A	0.00	N/A
19-Jan-94	EA-3	260.11	N/A	N/A	7.26	252.85	N/A	0.00	N/A
07-Mar-94	EA-3	260.11	N/A	N/A	6.53	253.58	N/A	0.00	N/A
29-Mar-94	EA-3	260.11	N/A	N/A	6.65	253.46	N/A	0.00	N/A
14-Apr-94	EA-3	260.11	SHEEN	N/A	7.26	252.85	N/A	SHEEN	N/A
21-Apr-94	EA-3	260.11	N/A	N/A	7.14	252.97	N/A	0.00	N/A
28-Apr-94	EA-3	260.11	N/A	N/A	7.44	252.67	N/A	0.00	N/A
04-May-94	EA-3	260.11	N/A	N/A	7.49	252.62	N/A	0.00	N/A
26-May-94	EA-3	260.11	SHEEN	N/A	7.89	252.22	N/A	SHEEN	N/A
20-Jul-94	EA-3	260.11	N/A	N/A	6.75	253.36	N/A	0.00	N/A
18-Aug-94	EA-3	260.11	N/A	N/A	7.01	253.10	N/A	0.00	N/A
30-Aug-94	EA-3	260.11	N/A	N/A	7.12	252.99	N/A	0.00	N/A
22-Sep-94	EA-3	260.11	N/A	N/A	7.10	253.01	N/A	0.00	N/A
25-Oct-94	EA-3	260.11	N/A	N/A	6.74	253.37	N/A	0.00	N/A
11-Jan-94	EA-4	260.63	N/A	N/A	8.05	252.58	N/A	0.00	N/A
19-Jan-94	EA-4	260.63	N/A	N/A	7.95	252.68	N/A	0.00	N/A
07-Mar-94	EA-4	260.63	N/A	N/A	7.23	253.40	N/A	0.00	N/A
29-Mar-94	EA-4	260.63	N/A	N/A	7.36	253.27	N/A	0.00	N/A
14-Apr-94	EA-4	260.63	N/A	N/A	7.94	252.69	N/A	0.00	N/A
21-Apr-94	EA-4	260.63	N/A	N/A	7.80	252.83	N/A	0.00	N/A
28-Apr-94	EA-4	260.63	N/A	N/A	8.12	252.51	N/A	0.00	N/A
26-May-94	EA-4	260.63	N/A	N/A	8.59	252.04	N/A	0.00	N/A
20-Jul-94	EA-4	260.63	N/A	N/A	7.40	253.23	N/A	0.00	N/A
18-Aug-94	EA-4	260.63	N/A	N/A	7.66	252.97	N/A	0.00	N/A
30-Aug-94	EA-4	260.63	N/A	N/A	7.77	252.86	N/A	0.00	N/A
22-Sep-94	EA-4	260.63	N/A	N/A	7.79	252.84	N/A	0.00	N/A
25-Oct-94	EA-4	260.63	N/A	N/A	7.39	253.24	N/A	0.00	N/A
11-Jan-94	EA-5	260.20	N/A	N/A	7.48	252.72	N/A	0.00	N/A
19-Jan-94	EA-5	260.20	N/A	N/A	7.39	252.81	N/A	0.00	N/A
07-Mar-94	EA-5	260.20	N/A	N/A	6.68	253.52	N/A	0.00	N/A
29-Mar-94	EA-5	260.20	N/A	N/A	6.81	253.39	N/A	0.00	N/A
14-Apr-94	EA-5	260.20	N/A	N/A	7.30	252.90	N/A	0.00	N/A
21-Apr-94	EA-5	260.20	N/A	N/A	7.20	253.00	N/A	0.00	N/A
28-Apr-94	EA-5	260.20	N/A	N/A	7.48	252.72	N/A	0.00	N/A
26-May-94	EA-5	260.20	N/A	N/A	7.94	252.26	N/A	0.00	N/A
20-Jul-94	EA-5	260.20	N/A	N/A	6.77	253.43	N/A	0.00	N/A
18-Aug-94	EA-5	260.20	N/A	N/A	7.05	253.15	N/A	0.00	N/A
30-Aug-94	EA-5	260.20	N/A	N/A	7.13	253.07	N/A	0.00	N/A
22-Sep-94	EA-5	260.20	N/A	N/A	7.16	253.04	N/A	0.00	N/A
25-Oct-94	EA-5	260.20	N/A	N/A	6.77	253.43	N/A	0.00	N/A
11-Jan-94	EA-6	260.09	N/A	N/A	7.51	252.58	N/A	0.00	N/A
19-Jan-94	EA-6	260.09	N/A	N/A	7.44	252.65	N/A	0.00	N/A
07-Mar-94	EA-6	260.09	N/A	N/A	6.72	253.37	N/A	0.00	N/A
29-Mar-94	EA-6	260.09	N/A	N/A	6.87	253.22	N/A	0.00	N/A
14-Apr-94	EA-6	260.09	N/A	N/A	7.33	252.76	N/A	0.00	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA.

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
21-Apr-94	EA-6	260.09	N/A	N/A	7.23	252.86	N/A	0.00	N/A
28-Apr-94	EA-6	260.09	N/A	N/A	7.51	252.58	N/A	0.00	N/A
26-May-94	EA-6	260.09	N/A	N/A	7.97	252.12	N/A	0.00	N/A
20-Jul-94	EA-6	260.09	N/A	N/A	6.78	253.31	N/A	0.00	N/A
18-Aug-94	EA-6	260.09	N/A	N/A	7.09	253.00	N/A	0.00	N/A
30-Aug-94	EA-6	260.09	N/A	N/A	7.16	252.93	N/A	0.00	N/A
22-Sep-94	EA-6	260.09	N/A	N/A	7.19	252.90	N/A	0.00	N/A
25-Oct-94	EA-6	260.09	N/A	N/A	6.81	253.28	N/A	0.00	N/A
11-Jan-94	EA-7	260.13	N/A	N/A	7.10	253.03	N/A	0.00	N/A
19-Jan-94	EA-7	260.13	N/A	N/A	6.97	253.16	N/A	0.00	N/A
07-Mar-94	EA-7	260.13	N/A	N/A	6.31	253.82	N/A	0.00	N/A
29-Mar-94	EA-7	260.13	N/A	N/A	6.36	253.77	N/A	0.00	N/A
14-Apr-94	EA-7	260.13	N/A	N/A	7.14	252.99	N/A	0.00	N/A
21-Apr-94	EA-7	260.13	N/A	N/A	7.06	253.07	N/A	0.00	N/A
28-Apr-94	EA-7	260.13	N/A	N/A	7.29	252.84	N/A	0.00	N/A
04-May-94	EA-7	260.13	N/A	N/A	7.31	252.82	N/A	0.00	N/A
26-May-94	EA-7	260.13	N/A	N/A	7.68	252.45	N/A	0.00	N/A
20-Jul-94	EA-7	260.13	N/A	N/A	6.75	253.38	N/A	0.00	N/A
18-Aug-94	EA-7	260.13	N/A	N/A	6.94	253.19	N/A	0.00	N/A
30-Aug-94	EA-7	260.13	N/A	N/A	7.11	253.02	N/A	0.00	N/A
22-Sep-94	EA-7	260.13	N/A	N/A	7.05	253.08	N/A	0.00	N/A
25-Oct-94	EA-7	260.13	N/A	N/A	6.77	253.36	N/A	0.00	N/A
11-Jan-94	EA-8	259.62	N/A	N/A	7.28	252.34	N/A	0.00	N/A
19-Jan-94	EA-8	259.62	N/A	N/A	7.19	252.43	N/A	0.00	N/A
07-Mar-94	EA-8	259.62	N/A	N/A	6.48	253.14	N/A	0.00	N/A
29-Mar-94	EA-8	259.62	N/A	N/A	6.60	253.02	N/A	0.00	N/A
14-Apr-94	EA-8	259.62	N/A	N/A	7.12	252.50	N/A	0.00	N/A
21-Apr-94	EA-8	259.62	N/A	N/A	6.99	252.63	N/A	0.00	N/A
28-Apr-94	EA-8	259.62	N/A	N/A	7.31	252.31	N/A	0.00	N/A
26-May-94	EA-8	259.62	N/A	N/A	7.76	251.86	N/A	0.00	N/A
20-Jul-94	EA-8	259.62	N/A	N/A	6.57	253.05	N/A	0.00	N/A
18-Aug-94	EA-8	259.62	N/A	N/A	6.84	252.78	N/A	0.00	N/A
30-Aug-94	EA-8	259.62	N/A	N/A	6.92	252.70	N/A	0.00	N/A
22-Sep-94	EA-8	259.62	N/A	N/A	6.91	252.71	N/A	0.00	N/A
25-Oct-94	EA-8	259.62	N/A	N/A	6.55	253.07	N/A	0.00	N/A
11-Jan-94	EA-9	260.63	N/A	N/A	7.91	252.72	N/A	0.00	N/A
19-Jan-94	EA-9	260.63	N/A	N/A	7.85	252.78	N/A	0.00	N/A
07-Mar-94	EA-9	260.63	N/A	N/A	7.11	253.52	N/A	0.00	N/A
29-Mar-94	EA-9	260.63	N/A	N/A	7.21	253.42	N/A	0.00	N/A
14-Apr-94	EA-9	260.63	N/A	N/A	7.87	252.76	N/A	0.00	N/A
21-Apr-94	EA-9	260.63	N/A	N/A	7.76	252.87	N/A	0.00	N/A
28-Apr-94	EA-9	260.63	N/A	N/A	8.06	252.57	N/A	0.00	N/A
26-May-94	EA-9	260.63	N/A	N/A	8.52	252.11	N/A	0.00	N/A
20-Jul-94	EA-9	260.63	N/A	N/A	7.40	253.23	N/A	0.00	N/A
18-Aug-94	EA-9	260.63	N/A	N/A	7.66	252.97	N/A	0.00	N/A
30-Aug-94	EA-9	260.63	N/A	N/A	7.78	252.85	N/A	0.00	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
22-Sep-94	EA-9	260.63	N/A	N/A	7.74	252.89	N/A	0.00	N/A
25-Oct-94	EA-9	260.63	N/A	N/A	7.41	253.22	N/A	0.00	N/A
11-Jan-94	EA-10	260.01	N/A	N/A	7.33	252.68	N/A	0.00	N/A
19-Jan-94	EA-10	260.01	N/A	N/A	7.21	252.80	N/A	0.00	N/A
07-Mar-94	EA-10	260.01	N/A	N/A	6.56	253.45	N/A	0.00	N/A
29-Mar-94	EA-10	260.01	N/A	N/A	6.61	253.40	N/A	0.00	N/A
14-Apr-94	EA-10	260.01	N/A	N/A	7.25	252.76	N/A	0.00	N/A
21-Apr-94	EA-10	260.01	N/A	N/A	7.11	252.90	N/A	0.00	N/A
28-Apr-94	EA-10	260.01	N/A	N/A	7.46	252.55	N/A	0.00	N/A
26-May-94	EA-10	260.01	N/A	N/A	7.80	252.21	N/A	0.00	N/A
20-Jul-94	EA-10	260.01	N/A	N/A	6.66	253.35	N/A	0.00	N/A
18-Aug-94	EA-10	260.01	N/A	N/A	6.84	253.17	N/A	0.00	N/A
30-Aug-94	EA-10	260.01	N/A	N/A	6.98	253.03	N/A	0.00	N/A
22-Sep-94	EA-10	260.01	N/A	N/A	6.97	253.04	N/A	0.00	N/A
25-Oct-94	EA-10	260.01	N/A	N/A	6.65	253.36	N/A	0.00	N/A
18-Aug-94	EA-11	259.74	N/A	N/A	6.24	253.50	N/A	0.00	N/A
30-Aug-94	EA-11	259.74	N/A	N/A	6.36	253.38	N/A	0.00	N/A
22-Sep-94	EA-11	259.74	N/A	N/A	6.34	253.40	N/A	0.00	N/A
25-Oct-94	EA-11	259.74	N/A	N/A	6.00	253.74	N/A	0.00	N/A
18-Aug-94	EA-12	259.48	N/A	N/A	5.83	253.65	N/A	0.00	N/A
30-Aug-94	EA-12	259.48	N/A	N/A	5.97	253.51	N/A	0.00	N/A
22-Sep-94	EA-12	259.48	N/A	N/A	5.94	253.54	N/A	0.00	N/A
25-Oct-94	EA-12	259.48	N/A	N/A	5.58	253.90	N/A	0.00	N/A
18-Aug-94	EA-13	259.40	N/A	N/A	4.76	254.64	N/A	0.00	N/A
30-Aug-94	EA-13	259.40	N/A	N/A	4.94	254.46	N/A	0.00	N/A
22-Sep-94	EA-13	259.40	N/A	N/A	4.88	254.52	N/A	0.00	N/A
25-Oct-94	EA-13	259.40	N/A	N/A	4.46	254.94	N/A	0.00	N/A
18-Aug-94	EA-14	259.68	N/A	N/A	5.35	254.33	N/A	0.00	N/A
30-Aug-94	EA-14	259.68	N/A	N/A	5.68	254.00	N/A	0.00	N/A
22-Sep-94	EA-14	259.68	N/A	N/A	5.61	254.07	N/A	0.00	N/A
25-Oct-94	EA-14	259.68	N/A	N/A	5.19	254.49	N/A	0.00	N/A
18-Aug-94	EA-15	260.12	N/A	N/A	5.29	254.83	N/A	0.00	N/A
30-Aug-94	EA-15	260.12	N/A	N/A	5.48	254.64	N/A	0.00	N/A
22-Sep-94	EA-15	260.12	N/A	N/A	5.34	254.78	N/A	0.00	N/A
25-Oct-94	EA-15	260.12	N/A	N/A	5.05	255.07	N/A	0.00	N/A
18-Aug-94	EA-16	259.25	N/A	N/A	6.21	253.04	N/A	0.00	N/A
30-Aug-94	EA-16	259.25	N/A	N/A	6.35	252.90	N/A	0.00	N/A
22-Sep-94	EA-16	259.25	N/A	N/A	6.31	252.94	N/A	0.00	N/A
25-Oct-94	EA-16	259.25	N/A	N/A	5.98	253.27	N/A	0.00	N/A
15-Aug-94	EA-17	259.10	N/A	N/A	6.20	252.90	N/A	0.00	N/A
18-Aug-94	EA-17	259.10	N/A	N/A	6.15	252.95	N/A	0.00	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA. 11206.69

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
30-Aug-94	EA-17	259.10	N/A	N/A	6.18	252.92	N/A	0.00	N/A
22-Sep-94	EA-17	259.10	N/A	N/A	6.55	252.55	N/A	0.00	N/A
25-Oct-94	EA-17	259.10	N/A	N/A	5.74	253.36	N/A	0.00	N/A
15-Aug-94	EA-18	259.42	N/A	N/A	4.74	254.68	N/A	0.00	N/A
18-Aug-94	EA-18	259.42	N/A	N/A	4.92	254.50	N/A	0.00	N/A
30-Aug-94	EA-18	259.42	N/A	N/A	5.05	254.37	N/A	0.00	N/A
22-Sep-94	EA-18	259.42	N/A	N/A	5.03	254.39	N/A	0.00	N/A
25-Oct-94	EA-18	259.42	N/A	N/A	5.03	254.39	N/A	0.00	N/A
15-Aug-94	EA-19	259.47	N/A	N/A	2.90	256.57	N/A	0.00	N/A
18-Aug-94	EA-19	259.47	N/A	N/A	2.95	256.52	N/A	0.00	N/A
30-Aug-94	EA-19	259.47	N/A	N/A	2.99	256.48	N/A	0.00	N/A
22-Sep-94	EA-19	259.47	N/A	N/A	3.42	256.05	N/A	0.00	N/A
25-Oct-94	EA-19	259.47	N/A	N/A	2.78	256.69	N/A	0.00	N/A
15-Aug-94	EA-20	259.50	N/A	N/A	6.62	252.88	N/A	0.00	N/A
18-Aug-94	EA-20	259.50	N/A	N/A	6.68	252.82	N/A	0.00	N/A
30-Aug-94	EA-20	259.50	N/A	N/A	6.33	253.17	N/A	0.00	N/A
22-Sep-94	EA-20	259.50	N/A	N/A	6.83	252.67	N/A	0.00	N/A
25-Oct-94	EA-20	259.50	N/A	N/A	~~6.65~~ 7.65 - [illegible]	252.85	N/A	0.00	N/A
18-Aug-94	EA-21	259.52	N/A	N/A	5.08	254.44	N/A	0.00	N/A
30-Aug-94	EA-21	259.52	N/A	N/A	5.42	254.10	N/A	0.00	N/A
22-Sep-94	EA-21	259.52	N/A	N/A	5.39	254.13	N/A	0.00	N/A
25-Oct-94	EA-21	NOT GAUGED - WELL BURIED							
18-Aug-94	EA-22	260.25	N/A	N/A	6.94	253.31	N/A	0.00	N/A
30-Aug-94	EA-22	260.25	N/A	N/A	7.04	253.21	N/A	0.00	N/A
22-Sep-94	EA-22	260.25	N/A	N/A	7.13	253.12	N/A	0.00	N/A
25-Oct-94	EA-22	260.25	N/A	N/A	6.67	253.58	N/A	0.00	N/A
15-Aug-94	EA-23	259.78	N/A	N/A	7.30	252.48	N/A	0.00	N/A
18-Aug-94	EA-23	259.78	N/A	N/A	7.17	252.61	N/A	0.00	N/A
30-Aug-94	EA-23	259.78	N/A	N/A	7.20	252.58	N/A	0.00	N/A
22-Sep-94	EA-23	259.78	N/A	N/A	7.25	252.53	N/A	0.00	N/A
25-Oct-94	EA-23	259.78	N/A	N/A	6.89	252.89	N/A	0.00	N/A
SITE 70 VENT WELL GAUGING:									
01-Nov-93	VW-1	N/A	7.96	N/A	7.99	N/A	N/A	0.03	0.01
02-Nov-93	VW-1	N/A	7.94	N/A	7.96	N/A	N/A	0.02	0.01
05-Nov-93	VW-1	N/A	N/A	N/A	7.78	N/A	N/A	0.00	N/A
10-Nov-93	VW-1	N/A	N/A	N/A	7.69	N/A	N/A	0.00	N/A
17-Nov-93	VW-1	N/A	N/A	N/A	7.79	N/A	N/A	0.00	N/A
07-Jan-94	VW-1	N/A	N/A	N/A	7.29	N/A	N/A	0.00	N/A
07-Mar-94	VW-1	N/A	N/A	N/A	6.47	N/A	N/A	0.00	N/A
29-Mar-94	VW-1	N/A	N/A	N/A	6.56	N/A	N/A	0.00	N/A
14-Apr-94	VW-1	N/A	N/A	N/A	7.16	N/A	N/A	0.00	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA 11206.69

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
28-Apr-94	VW-1	N/A	N/A	N/A	7.33	N/A	N/A	0.00	N/A
26-May-94	VW-1	N/A	N/A	N/A	7.79	N/A	N/A	0.00	N/A
26-Jul-94	VW-1	N/A	SHEEN	N/A	6.73	N/A	N/A	SHEEN	N/A
25-Oct-94	VW-1	N/A	N/A	N/A	6.66	N/A	N/A	0.00	N/A
01-Nov-93	VW-2	N/A	7.98	N/A	7.99	N/A	N/A	0.01	0.00
02-Nov-93	VW-2	N/A	SHEEN	N/A	7.97	N/A	N/A	SHEEN	N/A
05-Nov-93	VW-2	N/A	N/A	N/A	7.70	N/A	N/A	0.00	N/A
10-Nov-93	VW-2	N/A	N/A	N/A	7.72	N/A	N/A	0.00	N/A
17-Nov-93	VW-2	N/A	N/A	N/A	7.79	N/A	N/A	0.00	N/A
07-Jan-94	VW-2	N/A	N/A	N/A	7.33	N/A	N/A	0.00	N/A
07-Mar-94	VW-2	N/A	N/A	N/A	6.48	N/A	N/A	0.00	N/A
08-Mar-94	VW-2	N/A	N/A	N/A	6.47	N/A	N/A	0.00	N/A
29-Mar-94	VW-2	N/A	N/A	N/A	6.52	N/A	N/A	0.00	N/A
14-Apr-94	VW-2	N/A	N/A	N/A	7.17	N/A	N/A	0.00	N/A
28-Apr-94	VW-2	N/A	N/A	N/A	7.35	N/A	N/A	0.00	N/A
26-May-94	VW-2	N/A	N/A	N/A	7.81	N/A	N/A	0.00	N/A
26-Jul-94	VW-2	N/A	N/A	N/A	6.65	N/A	N/A	0.00	N/A
25-Oct-94	VW-2	N/A	N/A	N/A	6.65	N/A	N/A	0.00	N/A
01-Nov-93	VW-3	260.08	7.96	252.12	8.21	251.87	252.07	0.25	0.12
02-Nov-93	VW-3	260.08	7.98	252.10	8.01	252.07	252.09	0.03	0.02
05-Nov-93	VW-3	260.08	7.80	252.28	7.82	252.26	252.28	0.02	0.02
10-Nov-93	VW-3	260.08	N/A	N/A	7.73	252.35	N/A	0.00	N/A
17-Nov-93	VW-3	260.08	N/A	N/A	7.81	252.27	N/A	0.00	N/A
07-Jan-94	VW-3	260.08	N/A	N/A	7.36	252.72	N/A	0.00	N/A
07-Mar-94	VW-3	260.08	N/A	N/A	6.51	253.57	N/A	0.00	N/A
29-Mar-94	VW-3	260.08	N/A	N/A	6.60	253.48	N/A	0.00	N/A
14-Apr-94	VW-3	260.08	N/A	N/A	7.19	252.89	N/A	0.00	N/A
28-Apr-94	VW-3	260.08	N/A	N/A	7.38	252.70	N/A	0.00	N/A
26-May-94	VW-3	260.08	N/A	N/A	7.83	252.25	N/A	0.00	N/A
26-Jul-94	VW-3	260.08	N/A	N/A	6.65	253.43	N/A	0.00	N/A
25-Oct-94	VW-3	260.08	6.65	253.43	6.78	253.30	253.41	0.13	0.00
01-Nov-93	VW-4	N/A	N/A	N/A	8.09	N/A	N/A	0.00	N/A
02-Nov-93	VW-4	N/A	N/A	N/A	8.14	N/A	N/A	0.00	N/A
05-Nov-93	VW-4	N/A	N/A	N/A	7.52	N/A	N/A	0.00	N/A
10-Nov-93	VW-4	N/A	N/A	N/A	7.99	N/A	N/A	0.00	N/A
17-Nov-93	VW-4	N/A	N/A	N/A	8.12	N/A	N/A	0.00	N/A
07-Jan-94	VW-4	N/A	N/A	N/A	7.67	N/A	N/A	0.00	N/A
07-Mar-94	VW-4	N/A	N/A	N/A	6.75	N/A	N/A	0.00	N/A
18-Mar-94	VW-4	N/A	N/A	N/A	7.12	N/A	N/A	0.00	N/A
29-Mar-94	VW-4	N/A	N/A	N/A	6.69	N/A	N/A	0.00	N/A
14-Apr-94	VW-4	N/A	N/A	N/A	7.48	N/A	N/A	0.00	N/A
28-Apr-94	VW-4	N/A	N/A	N/A	7.68	N/A	N/A	0.00	N/A
26-May-94	VW-4	N/A	N/A	N/A	8.15	N/A	N/A	0.00	N/A
26-Jul-94	VW-4	N/A	N/A	N/A	6.94	N/A	N/A	0.00	N/A
25-Oct-94	VW-4	N/A	N/A	N/A	6.91	N/A	N/A	0.00	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA.

11206.69

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
01-Nov-93	VW-5	N/A	N/A	N/A	8.00	N/A	N/A	0.00	N/A
02-Nov-93	VW-5	N/A	N/A	N/A	8.00	N/A	N/A	0.00	N/A
05-Nov-93	VW-5	N/A	N/A	N/A	7.22	N/A	N/A	0.00	N/A
10-Nov-93	VW-5	N/A	N/A	N/A	7.77	N/A	N/A	0.00	N/A
17-Nov-93	VW-5	N/A	N/A	N/A	7.85	N/A	N/A	0.00	N/A
07-Jan-94	VW-5	N/A	N/A	N/A	7.38	N/A	N/A	0.00	N/A
07-Mar-94	VW-5	N/A	6.52	N/A	6.55	N/A	N/A	0.03	–
08-Mar-94	VW-5			NOT GAUGED:		MANUAL PRODUCT RECOVERY =			0.02
18-Mar-94	VW-5	N/A	N/A	N/A	6.89	N/A	N/A	0.00	N/A
29-Mar-94	VW-5	N/A	6.30	N/A	6.31	N/A	N/A	0.01	–
07-Apr-94	VW-5	N/A	N/A	N/A	7.12	N/A	N/A	0.00	N/A
14-Apr-94	VW-5	N/A	N/A	N/A	7.31	N/A	N/A	0.00	N/A
28-Apr-94	VW-5	N/A	SHEEN	N/A	7.43	N/A	N/A	SHEEN	N/A
04-May-94	VW-5	N/A	N/A	N/A	7.22	N/A	N/A	0.00	N/A
26-May-94	VW-5	N/A	SHEEN	N/A	7.92	N/A	N/A	SHEEN	N/A
26-Jul-94	VW-5	N/A	6.79	N/A	6.84	N/A	N/A	0.05	0.02
25-Oct-94	VW-5	N/A	6.71	N/A	6.77	N/A	N/A	0.06	0.00
01-Nov-93	VW-6	N/A	7.87	N/A	7.94	N/A	N/A	0.07	0.02
02-Nov-93	VW-6	N/A	7.89	N/A	7.90	N/A	N/A	0.01	–
05-Nov-93	VW-6	N/A	6.92	N/A	6.93	N/A	N/A	0.01	0.01
10-Nov-93	VW-6	N/A	7.66	N/A	7.67	N/A	N/A	0.01	0.02
17-Nov-93	VW-6	N/A	N/A	N/A	7.75	N/A	N/A	0.00	N/A
07-Jan-94	VW-6	N/A	N/A	N/A	7.28	N/A	N/A	0.00	N/A
07-Mar-94	VW-6	N/A	6.41	N/A	6.43	N/A	N/A	0.02	–
08-Mar-94	VW-6			NOT GAUGED:		MANUAL PRODUCT RECOVERY =			0.005
18-Mar-94	VW-6	N/A	N/A	N/A	6.80	N/A	N/A	0.00	N/A
29-Mar-94	VW-6	N/A	6.22	N/A	6.35	N/A	N/A	0.13	0.3
07-Apr-94	*VW-6	N/A	N/A	N/A	7.07	N/A	N/A	0.00	N/A
14-Apr-94	*VW-6	N/A	N/A	N/A	7.19	N/A	N/A	0.00	0.01
21-Apr-94	VW-6	N/A	N/A	N/A	7.09	N/A	N/A	0.00	N/A
28-Apr-94	VW-6	N/A	N/A	N/A	7.33	N/A	N/A	0.00	N/A
04-May-94	VW-6	N/A	N/A	N/A	7.16	N/A	N/A	0.00	N/A
26-May-94	VW-6	N/A	N/A	N/A	7.82	N/A	N/A	0.00	N/A
26-Jul-94	VW-6	N/A	6.66	N/A	6.67	N/A	N/A	0.01	0.01
25-Oct-94	VW-6	N/A	6.63	N/A	6.64	N/A	N/A	0.01	0.00
01-Nov-93	VW-7	260.34	8.00	252.34	8.34	252.00	252.28	0.34	0.20
02-Nov-93	VW-7	260.34	8.00	252.34	8.34	252.00	252.28	0.34	0.15
05-Nov-93	VW-7	260.34	7.53	252.81	7.87	252.47	252.75	0.34	0.18
10-Nov-93	VW-7	260.34	7.78	252.56	8.11	252.23	252.50	0.33	0.20
17-Nov-93	*VW-7	260.34	8.05	252.29	8.23	252.11	252.26	0.18	0.02
07-Jan-94	*VW-7	260.34	7.39	252.95	7.66	252.68	252.90	0.27	0.15
21-Jan-94	*VW-7	260.34	7.35	252.99	7.57	252.77	252.95	0.22	1.1
07-Mar-94	*VW-7	260.34	6.56	253.78	6.73	253.61	253.75	0.17	0.2
08-Mar-94	VW-7			NOT GAUGED:		MANUAL PRODUCT RECOVERY =			0.2
18-Mar-94	*VW-7	260.34	6.88	253.46	7.00	253.34	253.44	0.12	0.2
29-Mar-94	*VW-7	260.34	6.55	253.79	6.73	253.61	253.76	0.18	0.7
07-Apr-94	*VW-7	260.34	7.14	253.20	7.29	253.05	253.17	0.15	0.5

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA.

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
14-Apr-94	VW-7	260.34	7.28	253.06	7.51	252.83	253.02	0.23	0.1
21-Apr-94	*VW-7	260.34	7.21	253.13	7.35	252.99	253.10	0.14	0.05
28-Apr-94	*VW-7	260.34	7.55	252.79	7.65	252.69	252.77	0.10	0.1
04-May-94	*VW-7	260.34	7.50	252.84	7.58	252.76	252.82	0.08	0.1
10-May-94	*VW-7	260.34	7.71	252.63	7.81	252.53	252.61	0.10	0.1
26-May-94	*VW-7	260.34	8.08	252.26	8.17	252.17	252.24	0.09	0.05
03-Jun-94	VW-7	260.34	8.25	252.09	8.33	252.01	252.07	0.08	0.1
08-Jun-94	VW-7	260.34	8.01	252.33	8.35	251.99	252.27	0.34	0.25
17-Jun-94	VW-7	260.34	SHEEN	N/A	7.56	252.78	N/A	SHEEN	N/A
20-Jun-94	VW-7.	260.34	7.88	252.46	8.21	252.13	252.40	0.33	0.30
18-Jul-94	VW-7	260.34	6.81	253.53	6.83	253.51	253.53	0.02	0.01
26-Jul-94	VW-7	260.34	N/A	N/A	6.84	253.50	N/A	0.00	N/A
02-Aug-94	VW-7	260.34	N/A	N/A	6.86	253.48	N/A	0.00	N/A
09-Aug-94	VW-7	260.34	SHEEN	N/A	7.05	253.29	N/A	SHEEN	N/A
18-Aug-94	VW-7	260.34	7.02	253.32	7.04	253.30	253.32	0.02	0.00
08-Sep-94	VW-7	260.34	7.32	253.02	7.39	252.95	253.01	0.07	0.05
22-Sep-94	VW-7	260.34	N/A	N/A	7.20	253.14	N/A	0.00	N/A
30-Sep-94	VW-7	260.34	7.44	252.90	7.45	252.89	252.90	0.01	0.00
14-Oct-94	VW-7	260.34	N/A	N/A	6.86	253.48	N/A	0.00	N/A
25-Oct-94	VW-7	260.34	SHEEN	N/A	6.83	253.51	N/A	SHEEN	0.00
01-Nov-93	VW-8	N/A	7.97	N/A	8.45	N/A	N/A	0.48	0.25
02-Nov-93	VW-8	N/A	8.04	N/A	8.15	N/A	N/A	0.11	0.08
05-Nov-93	VW-8	N/A	7.91	N/A	7.96	N/A	N/A	0.05	0.02
10-Nov-93	VW-8	N/A	7.84	N/A	7.88	N/A	N/A	0.04	0.03
17-Nov-93	*VW-8	N/A	N/A	N/A	7.95	N/A	N/A	0.00	N/A
07-Jan-94	*VW-8	N/A	7.37	N/A	7.69	N/A	N/A	0.32	0.2
21-Jan-94	*VW-8	N/A	7.29	N/A	7.60	N/A	N/A	0.31	1.0
07-Mar-94	VW-8	N/A	6.51	N/A	6.85	N/A	N/A	0.34	0.8
08-Mar-94	*VW-8	N/A	6.64	N/A	6.91	N/A	N/A	0.27	0.55
09-Mar-94	*VW-8	N/A	6.64	N/A	6.92	N/A	N/A	0.28	1.25
18-Mar-94	*VW-8	N/A	6.90	N/A	7.11	N/A	N/A	0.21	1.0
29-Mar-94	*VW-8	N/A	6.61	N/A	6.91	N/A	N/A	0.30	1.2
31-Mar-94	*VW-8	N/A	6.51	N/A	6.78	N/A	N/A	0.27	0.4
07-Apr-94	*VW-8	N/A	7.18	N/A	7.51	N/A	N/A	0.33	0.8
14-Apr-94	*VW-8	N/A	7.33	N/A	7.60	N/A	N/A	0.27	0.05
14-21 Apr 94	^VW-8						SKIMMER BELT RECOVERY =		1.0
21-Apr-94	VW-8	N/A	7.23	N/A	7.60	N/A	N/A	0.37	0.10
28-Apr-94	*VW-8	N/A	N/A	N/A	7.55	N/A	N/A	0.00	0.05
04-May-94	VW-8	N/A	7.57	N/A	7.60	N/A	N/A	0.03	0.05
10-May-94	*VW-8	N/A	N/A	N/A	7.70	N/A	N/A	0.00	N/A
26-May-94	*VW-8	N/A	SHEEN	N/A	7.97	N/A	N/A	SHEEN	0.001
03-Jun-94	VW-8	N/A	N/A	N/A	8.14	N/A	N/A	0.00	N/A
08-Jun-94	VW-8	N/A	N/A	N/A	8.12	N/A	N/A	0.00	N/A
17-Jun-94	VW-8	N/A	N/A	N/A	8.05	N/A	N/A	0.00	N/A
20-Jun-94	VW-8	N/A	7.99	N/A	8.00	N/A	N/A	0.01	0.00
18-Jul-94	VW-8	N/A	N/A	N/A	6.81	N/A	N/A	0.00	N/A
26-Jul-94	VW-8	N/A	N/A	N/A	6.93	N/A	N/A	0.00	N/A
02-Aug-94	VW-8	N/A	N/A	N/A	6.98	N/A	N/A	0.00	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA

11206.69

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
09-Aug-94	VW-8	N/A	SHEEN	N/A	7.14	N/A	N/A	SHEEN	N/A
18-Aug-94	VW-8	N/A	SHEEN	N/A	7.11	N/A	N/A	SHEEN	N/A
08-Sep-94	VW-8	N/A	7.43	N/A	7.45	N/A	N/A	0.02	0.01
22-Sep-94	VW-8	N/A	N/A	N/A	7.26	N/A	N/A	0.00	N/A
30-Sep-94	VW-8	N/A	7.49	N/A	7.55	N/A	N/A	0.06	0.05
14-Oct-94	VW-8	N/A	N/A	N/A	6.98	N/A	N/A	0.00	N/A
25-Oct-94	VW-8	N/A	6.92	N/A	6.98	N/A	N/A	0.06	0.00
01-Nov-93	VW-9	N/A	8.21	N/A	8.34	N/A	N/A	0.13	0.1
02-Nov-93	VW-9	N/A	8.25	N/A	8.28	N/A	N/A	0.03	0.05
05-Nov-93	VW-9	N/A	7.70	N/A	7.81	N/A	N/A	0.11	0.07
10-Nov-93	VW-9	N/A	8.04	N/A	8.15	N/A	N/A	0.11	0.05
17-Nov-93	*VW-9	N/A	8.14	N/A	8.19	N/A	N/A	0.05	0.01
07-Jan-94	*VW-9	N/A	7.65	N/A	7.79	N/A	N/A	0.14	0.05
21-Jan-94	*VW-9	N/A	7.54	N/A	7.58	N/A	N/A	0.04	0.05
07-Mar-94	*VW-9	N/A	6.81	N/A	6.84	N/A	N/A	0.03	0.1
09-Mar-94	*VW-9	N/A	N/A	N/A	6.89	N/A	N/A	0.00	0.01
18-Mar-94	*VW-9	N/A	7.01	N/A	7.03	N/A	N/A	0.02	–
29-Mar-94	*VW-9	N/A	6.63	N/A	6.69	N/A	N/A	0.06	0.1
07-Apr-94	*VW-9	N/A	7.45	N/A	7.49	N/A	N/A	0.04	0.1
14-Apr-94	*VW-9	N/A	N/A	N/A	7.65	N/A	N/A	0.00	0.01
21-Apr-94	VW-9	N/A	N/A	N/A	7.56	N/A	N/A	0.00	N/A
28-Apr-94	VW-9	N/A	N/A	N/A	7.81	N/A	N/A	0.00	N/A
04-May-94	VW-9	N/A	7.66	N/A	7.68	N/A	N/A	0.02	0.03
10-May-94	VW-9	N/A	N/A	N/A	7.93	N/A	N/A	0.00	N/A
26-May-94	VW-9	N/A	8.23	N/A	8.28	N/A	N/A	0.05	0.01
18-Jul-94	VW-9	N/A	7.13	N/A	7.17	N/A	N/A	0.04	0.02
26-Jul-94	VW-9	N/A	N/A	N/A	7.16	N/A	N/A	0.00	N/A
08-Sep-94	VW-9	N/A	7.68	N/A	7.71	N/A	N/A	0.03	0.02
22-Sep-94	VW-9	N/A	7.56	N/A	7.57	N/A	N/A	0.01	0.00
30-Sep-94	VW-9	N/A	N/A	N/A	7.45	N/A	N/A	0.00	N/A
25-Oct-94	VW-9	N/A	7.12	N/A	7.14	N/A	N/A	0.02	0.00
01-Nov-93	VW-10	N/A	8.16	N/A	8.39	N/A	8.20	0.23	0.15
02-Nov-93	VW-10	N/A	8.22	N/A	8.27	N/A	8.23	0.05	0.05
05-Nov-93	VW-10	N/A	7.74	N/A	7.78	N/A	7.75	0.04	0.04
10-Nov-93	VW-10	N/A	8.03	N/A	8.04	N/A	8.03	0.01	0.01
17-Nov-93	VW-10	N/A	N/A	N/A	8.12	N/A	N/A	0.00	N/A
07-Jan-94	VW-10	N/A	N/A	N/A	7.67	N/A	N/A	0.00	N/A
07-Mar-94	VW-10	N/A	6.74	N/A	6.94	N/A	6.78	0.20	0.40
09-Mar-94	*VW-10	N/A	N/A	N/A	6.93	N/A	N/A	0.00	0.005
29-Mar-94	*VW-10	N/A	N/A	N/A	6.88	N/A	N/A	0.00	0.005
14-Apr-94	VW-10	N/A	N/A	N/A	7.59	N/A	N/A	0.00	N/A
21-Apr-94	VW-10	N/A	N/A	N/A	7.49	N/A	N/A	0.00	N/A
28-Apr-94	VW-10	N/A	N/A	N/A	7.74	N/A	N/A	0.00	N/A
04-May-94	VW-10	N/A	N/A	N/A	7.71	N/A	N/A	0.00	N/A
26-May-94	VW-10	N/A	N/A	N/A	8.17	N/A	N/A	0.00	N/A
26-Jul-94	VW-10	N/A	N/A	N/A	7.09	N/A	N/A	0.00	N/A
25-Oct-94	VW-10	N/A	SHEEN	N/A	7.09	N/A	N/A	SHEEN	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
01-Nov-93	VW-11	N/A	N/A	N/A	8.20	N/A	N/A	0.00	N/A
02-Nov-93	VW-11	N/A	N/A	N/A	8.19	N/A	N/A	0.00	N/A
05-Nov-93	VW-11	N/A	N/A	N/A	8.02	N/A	N/A	0.00	N/A
10-Nov-93	VW-11	N/A	N/A	N/A	7.89	N/A	N/A	0.00	N/A
17-Nov-93	VW-11	N/A	N/A	N/A	8.12	N/A	N/A	0.00	N/A
07-Jan-94	VW-11	N/A	N/A	N/A	7.64	N/A	N/A	0.00	N/A
07-Mar-94	VW-11	N/A	N/A	N/A	6.64	N/A	N/A	0.00	N/A
29-Mar-94	VW-11	N/A	N/A	N/A	6.87	N/A	N/A	0.00	N/A
14-Apr-94	VW-11	N/A	N/A	N/A	7.51	N/A	N/A	0.00	N/A
28-Apr-94	VW-11	N/A	N/A	N/A	7.73	N/A	N/A	0.00	N/A
26-May-94	VW-11	N/A	N/A	N/A	8.19	N/A	N/A	0.00	N/A
26-Jul-94	VW-11	N/A	N/A	N/A	6.85	N/A	N/A	0.00	N/A
25-Oct-94	VW-11	N/A	N/A	N/A	6.85	N/A	N/A	0.00	N/A
01-Nov-93	VW-12	N/A	N/A	N/A	7.58	N/A	N/A	0.00	N/A
02-Nov-93	VW-12	N/A	N/A	N/A	7.67	N/A	N/A	0.00	N/A
05-Nov-93	VW-12	N/A	N/A	N/A	7.37	N/A	N/A	0.00	N/A
10-Nov-93	VW-12	N/A	N/A	N/A	7.49	N/A	N/A	0.00	N/A
17-Nov-93	VW-12	N/A	N/A	N/A	7.65	N/A	N/A	0.00	N/A
07-Jan-94	VW-12	N/A	N/A	N/A	7.16	N/A	N/A	0.00	N/A
07-Mar-94	VW-12	N/A	N/A	N/A	6.29	N/A	N/A	0.00	N/A
29-Mar-94	VW-12	N/A	N/A	N/A	6.21	N/A	N/A	0.00	N/A
14-Apr-94	VW-12	N/A	N/A	N/A	7.09	N/A	N/A	0.00	N/A
28-Apr-94	VW-12	N/A	N/A	N/A	7.27	N/A	N/A	0.00	N/A
26-May-94	VW-12	N/A	N/A	N/A	7.69	N/A	N/A	0.00	N/A
26-Jul-94	VW-12	N/A	N/A	N/A	6.59	N/A	N/A	0.00	N/A
25-Oct-94	VW-12	N/A	N/A	N/A	6.54	N/A	N/A	0.00	N/A
01-Nov-93	VW-13	N/A	N/A	N/A	7.47	N/A	N/A	0.00	N/A
02-Nov-93	VW-13	N/A	N/A	N/A	7.45	N/A	N/A	0.00	N/A
05-Nov-93	VW-13	N/A	N/A	N/A	7.65	N/A	N/A	0.00	N/A
10-Nov-93	VW-13	N/A	N/A	N/A	7.49	N/A	N/A	0.00	N/A
17-Nov-93	VW-13	N/A	N/A	N/A	7.70	N/A	N/A	0.00	N/A
07-Jan-94	VW-13	N/A	N/A	N/A	7.26	N/A	N/A	0.00	N/A
07-Mar-94	VW-13	N/A	N/A	N/A	6.38	N/A	N/A	0.00	N/A
29-Mar-94	VW-13	N/A	N/A	N/A	6.02	N/A	N/A	0.00	N/A
14-Apr-94	VW-13	N/A	N/A	N/A	7.18	N/A	N/A	0.00	N/A
28-Apr-94	VW-13	N/A	N/A	N/A	7.37	N/A	N/A	0.00	N/A
26-May-94	VW-13	N/A	N/A	N/A	7.79	N/A	N/A	0.00	N/A
26-Jul-94	VW-13	N/A	N/A	N/A	6.64	N/A	N/A	0.00	N/A
25-Oct-94	VW-13	N/A	N/A	N/A	6.54	N/A	N/A	0.00	N/A
01-Nov-93	VW-14	260.26	8.15	252.11	8.20	252.06	252.10	0.05	0.02
02-Nov-93	VW-14	260.26	N/A	N/A	7.96	252.30	N/A	0.00	N/A
05-Nov-93	VW-14	260.26	N/A	N/A	7.65	252.61	N/A	0.00	N/A
10-Nov-93	VW-14	260.26	N/A	N/A	7.70	252.56	N/A	0.00	N/A
17-Nov-93	VW-14	260.26	N/A	N/A	7.93	252.33	N/A	0.00	N/A
07-Jan-94	VW-14	260.26	N/A	N/A	7.35	252.91	N/A	0.00	N/A

TABLE 6 (CONT) SUMMARY OF GAUGING DATA FOR UNDERGROUND STORAGE TANK SITES #70 AND #72, ROBINS AIR FORCE BASE, GEORGIA

Date	Well #	Casing Elev. (feet)	LPH Level (feet)	LPH Elev. (feet)	Water Level (feet)	Water Elev. (feet)	Corrected Water Elev. (feet)	LPH Thickness (feet)	LPH Recovered (gallons)
07-Mar-94	VW-14	260.26	N/A	N/A	6.51	253.75	N/A	0.00	N/A
29-Mar-94	VW-14	260.26	N/A	N/A	6.52	253.74	N/A	0.00	N/A
14-Apr-94	VW-14	260.26	N/A	N/A	7.33	252.93	N/A	0.00	N/A
28-Apr-94	VW-14	260.26	N/A	N/A	7.49	252.77	N/A	0.00	N/A
26-May-94	VW-14	260.26	N/A	N/A	7.90	252.36	N/A	0.00	N/A
26-Jul-94	VW-14	260.26	N/A	N/A	6.83	253.43	N/A	0.00	N/A
25-Oct-94	VW-14	260.26	N/A	N/A	6.85	253.41	N/A	0.00	N/A
08-Mar-94	VW-15	N/A	N/A	N/A	6.09	N/A	N/A	0.00	N/A
28-Apr-94	VW-15	N/A	N/A	N/A	6.39	N/A	N/A	0.00	N/A
26-May-94	VW-15	N/A	N/A	N/A	6.38	N/A	N/A	0.00	N/A
25-Oct-94	VW-15	N/A	N/A	N/A	6.36	N/A	N/A	0.00	N/A
08-Mar-94	VW-16	N/A	N/A	N/A	5.98	N/A	N/A	0.00	N/A
14-Apr-94	VW-16	N/A	N/A	N/A	6.78	N/A	N/A	0.00	N/A
28-Apr-94	VW-16	N/A	N/A	N/A	6.80	N/A	N/A	0.00	N/A
26-May-94	VW-16	N/A	N/A	N/A	6.80	N/A	N/A	0.00	N/A
25-Oct-94	VW-16	N/A	N/A	N/A	6.50	N/A	N/A	0.00	N/A

* = WELL WAS GAUGED FOLLOWING REMOVAL OF PASSIVE RECOVERY WICK
^ = LIQUID PHASE HYDROCARBON RECOVERY BY SKIMMER BELT ON THESE DATES

WELL #:	GALLONS RECOVERED:
EA-2	1097.30
VW-8	8.89
VW-7	5.01
EA-1	3.02
VW-9	0.78
VW-10	0.66
VW-6	0.38
VW-3	0.16
VW-5	0.04
VW-1	0.02
VW-14	0.02

TOTAL LPH RECOVERED TO DATE = 1116.3

APPENDIX D

LETTER DETAILING WATER DISCHARGE FLOWRATE AND CONCENTRATIONS

June 2,1995

Tom Kirby
CEOUW
Building 141, IWTP
Robins AFB, GA 31098

Attn: Mr. Tom Kirby, Water Facility PoC

Dear Mr. Kirby:

The purpose of this letter is to outline the expected water discharge flowrate and contaminant levels of Total Petroleum Hydrocarbons (TPH) and benzene in the discharge water from the short-term bioslurper pilot tests at Warner Robins AFB. There will be two sites at Warner Robins AFB where the bioslurper pilot tests will be performed. They are the SS010 site and the #70 and #72 underground storage tank (UST) area. These two sites are contaminated with JP-4 jet fuel.

A site assessment was performed at the #70 and #72 UST site in August of 1994. The analytical results obtained from the groundwater samples collected gave ranges of TPH from <0.5 to 600.0 mg/L. The results for benzene in the groundwater ranged from <0.001 to 4.2 mg/L. And the results for all BTEX compounds in the site groundwater ranged from <0.001 to 13.85 mg/L.

A separate site assessment was performed at the SS010 site in August of 1989. The analytical results obtained from the groundwater samples collected at this site gave benzene in a concentration of 9.7 mg/L, and total BTEX (benzene, toluene, ethylbenzene, and total xylenes) compounds in a concentration of 29.9 mg/L. There was no analysis for TPH performed during this site assessment.

The amount of contaminant levels for TPH and benzene found in the groundwater sampling during these site assessments is approximate to the levels of contamination in the groundwater experienced at two other bioslurper short-term test sites; Travis AFB, California and Andrews AFB, Maryland. The short-term bioslurper pilot test has already been performed at these two sites. The following table documents the water discharge flowrates and the concentrations of TPH, benzene, and total BTEX compounds found in the bioslurper system discharge samples from the two pilot test sites.

Table 1. Bioslurper System Discharge Data at Travis AFB, California and Andrews AFB, Maryland

Base	Water Discharge Rate (gal/min)	TPH Concentration (mg/L)	Benzene Concentration (mg/L)	BTEX Concentration (mg/L)
Andrews AFB	1.26	72	0.074	0.715
		49	0.042	0.743
Travis AFB	1.33	16.8	1.03	7.83

During the short-term test performed at Travis AFB the system discharge water was sent directly to a full-sized Baker tank. The water discharge samples were taken from the outlet of the bioslurper oil/water separator. Figure 1 shows a schematic of the bioslurper system. The oil/water separator is designed to allow the product, JP-4 jet fuel at Robins AFB, and the groundwater being extracted from the monitoring well to separate into two distinct phases. Since the concentration levels at Travis AFB were low, no additional unit operations were used to further separate the oil and water extracted from the monitoring well during the short-term test. However, at Andrews AFB the concentration levels of TPH (analyzed as diesel fuel) were high, and the wastewater was surface discharged. Also, due to the extreme vacuum exerted by the bioslurper pump, an emulsion of site soils and fuel formed in the oil/water separator. The oil/water unit was, therefore, unable to completely separate the oil and water phases. And the resultant water discharge stream (cloudy-white in appearance) had a TPH concentration of 400 mg/L. Due to the occurrence of the emulsion and the high TPH concentration in the discharge stream, an additional settling tank was used to allow the water discharge stream to "clean itself" before being discharged to the surface. Analysis of the water discharge from the settling tank showed that the TPH concentration was reduced to less than 100 mg/L and the benzene concentration in the stream was also reduced to less than 0.1 mg/L.

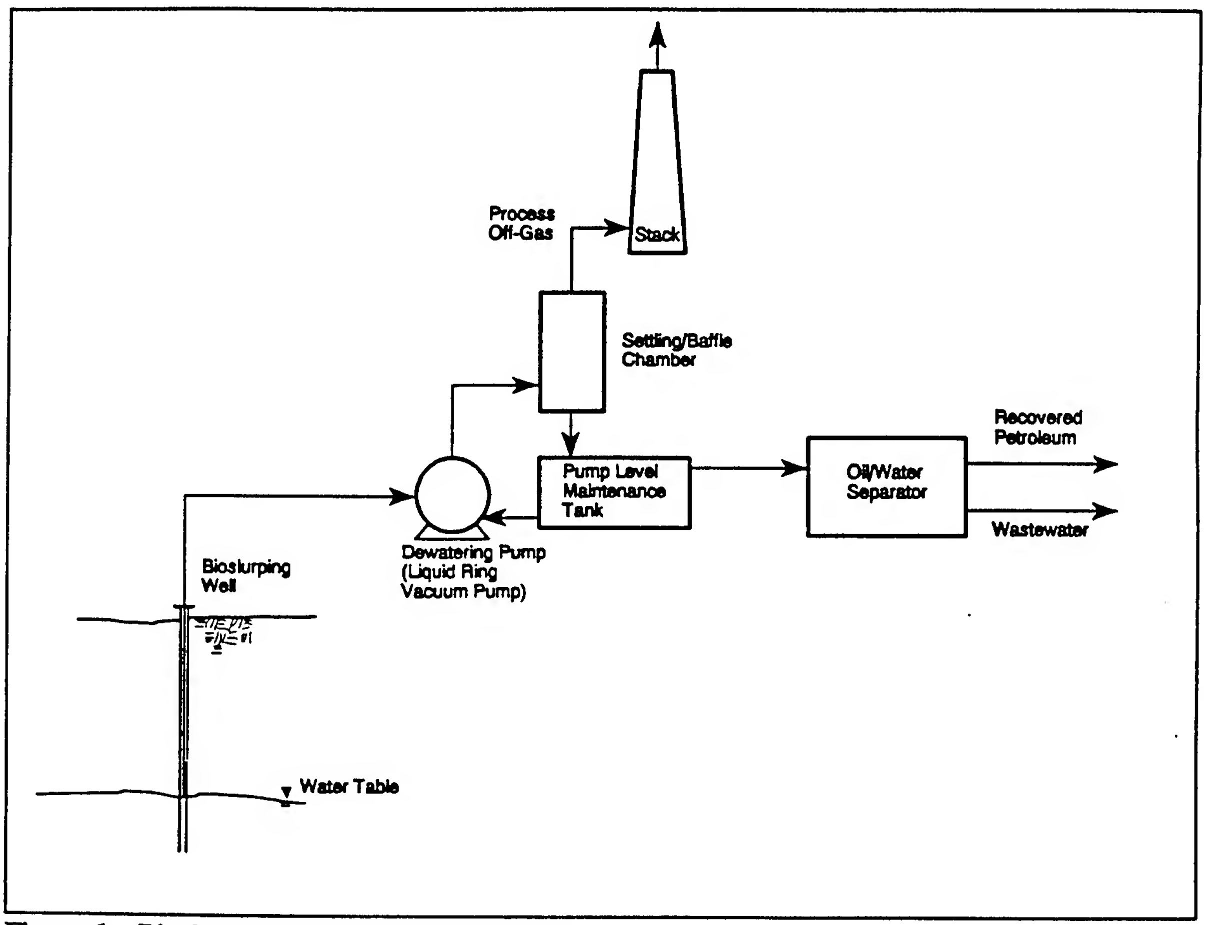


Figure 1. Bioslurper Process Flow Diagram

It is believed that at both Robins AFB test sites the concentrations of TPH and benzene in the water discharge stream will not exceed 100 mg TPH/L, and 1.0 mg benzene/L. We are therefore requesting to discharge the bioslurper system wastewater directly to the base sanitary sewer. We will monitor the concentration of TPH and benzene in the waste stream throughout the bioslurper short-term testing. An additional oil/water separator will be on-site to further separate the extracted fuel and water phases. And if additional operations (i.e. a settling tank) are needed to reduce contaminant levels in the discharge stream they will be employed.

The bioslurper short-term tests at Robins AFB are tenatively scheduled to begin July 10, 1995. We expect the field activities to be completed in approximately 4 weeks.

We believe that the wastewater from the bioslurper system will not exceed the 100 mg/L TPH level experienced at the aforementioned bioslurper pilot test sites, and that we should expect a water discharge rate of approximately 1.25 gpm. If you have any questions, comments, or require additional information, please call me at (614) 424-6122, or my colleague, Eric Drescher, at (614) 424-3088.

Sincerely,

Jeffrey A. Kittel
Program Manager
Environmental Restoration Department

JAK
Attachments
cc: Mike Stevens
WR-ALC EMR
216 Ocmulgee Court
Warner Robins AFB, GA 31098-1646

Mr. Mark Rounsavill, HSC/PKVBC
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Brooks AFB, TX 78235-5357

Mr. Leon Sultan
DCMAO Dayton
Gentile Station
1001 Hamilton Street
Dayton, OH 45444-5300

APPENDIX B

LABORATORY ANALYTICAL REPORTS

@ AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9508100

Work Order Summary

CLIENT: Mr. Eric Dreschler
Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

BILL TO: Same

PHONE: 614-424-3753
FAX: 614-424-3667
DATE RECEIVED: 8/15/95
DATE COMPLETED: 8/23/95

INVOICE # 7781
P.O. #
PROJECT # G462201-30B1501 Bioslurper
AMOUNT$: $568.51

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	PRICE
01A	R1-STACK-1 (9536)	TO-3	0.5 "Hg	$120.00
02A	R1-STACK-2 (94906)	TO-3	2.0 "Hg	$120.00
03A	R2-STACK-1 (9486)	TO-3	1.5 "Hg	$120.00
04A	R2-STACK-2 (9473)	TO-3	3.0 "Hg	$120.00
05A	Lab Blank	TO-3	NA	NC

Misc. Charges	1 Liter Summa Canister Preparation (4) @ $10.00 each.	$40.00
	Shipping (7/17/95)	$48.51

CERTIFIED BY: [signature]
Laboratory Director

DATE: 8/23/95

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME: R1-STACK-1 (9536)

ID#: 9508100-01A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6081808 Date of Collection: 8/5/95

Dil. Factor: 17000 Date of Analysis: 8/18/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	17	55	370	1200
Toluene	17	65	140	540
Ethyl Benzene	17	75	20	88
Total Xylenes	17	75	65	290

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name: 6081808 Date of Collection: 8/5/95

Dil. Factor: 17000 Date of Analysis: 8/18/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	170	1100	27000	180000
C2 - C4** Hydrocarbons	170	310	8300	15000

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: R1-STACK-2 (94906)

ID#: 9508100-02A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name:	6081814		Date of Collection: 8/6/95	
Dil. Factor:	22000		Date of Analysis: 8/18/95	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
Benzene	22	71	660	2100
Toluene	22	84	260	1000
Ethyl Benzene	22	97	43	190
Total Xylenes	22	97	130	570

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name:	6081814		Date of Collection: 8/6/95	
Dil. Factor:	22000		Date of Analysis: 8/18/95	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
TPH* (C5+ Hydrocarbons)	220	1400	47000	300000
C2 - C4** Hydrocarbons	220	400	11000	20000

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: R2-STACK-1 (9486)

ID#: 9508100-03A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name:	**6081813**			**Date of Collection: 8/10/95**	
Dil. Factor:	**11000**			**Date of Analysis: 8/18/95**	
Compound		**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
Benzene		11	36	830	2700
Toluene		11	42	890	3400
Ethyl Benzene		11	49	200	880
Total Xylenes		11	49	750	3300

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name:	**6081813**			**Date of Collection: 8/10/95**	
Dil. Factor:	**11000**			**Date of Analysis: 8/18/95**	
Compound		**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
TPH* (C5+ Hydrocarbons)		110	710	60000	390000
C2 - C4** Hydrocarbons		110	200	2800	5100

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: R2-STACK-2 (9473)

ID#: 9508100-04A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name:	6081816		Date of Collection: 8/11/95	
Dil. Factor:	220		Date of Analysis: 8/18/95	

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.22	0.71	13	42
Toluene	0.22	0.84	21	80
Ethyl Benzene	0.22	0.97	6.7	30
Total Xylenes	0.22	0.97	29	130

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name:	6081816		Date of Collection: 8/11/95	
Dil. Factor:	220		Date of Analysis: 8/18/95	

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	2.2	14	680	4400
C2 - C4** Hydrocarbons	2.2	4.0	69	130

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank

ID#: 9508100-05A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name:	6081807	**Date of Collection:**	NA
Dil. Factor:	1.0	**Date of Analysis:**	8/18/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name:	6081807	**Date of Collection:**	NA
Dil. Factor:	1.0	**Date of Analysis:**	8/18/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.010	0.065	Not Detected	Not Detected
C2 - C4** Hydrocarbons	0.010	0.018	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

No 004465
Page 1 of 1

Contact Person AL POLLACK / ERIC DRESCHER
Company BATTELLE
Address 505 KING AVE City COLUMBUS State OH Zip 43201
Phone 614 - 424 - 3753 FAX 614 - 424 - 3667
Collected By: Signature [signature]

Project Info:
P.O. # CONTACT A. BUSH 614-424-4996
Project # G462201-30B1501
Project Name BIOSLURPER

Turn Around Time:
☒ Normal
☐ Rush ______ Specify

	Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
01A	9536	R1 - STACK - 1	8/5/95 1:00pm	BTEX / TPH (as ~~Gasoline~~ Jet Fuel)	29.5	ATM	6.5"Hg
02A	94906	R1 - STACK - 2	8/6/95 1:30pm	"	29.5	ATM	2.0"Hg
03A	9486	R2 - STACK - 1	8/10/95 4:30pm	"	29	ATM	1.5"Hg
04A	9473	R2 - STACK - 2	8/11/95 3:00pm	"	21.5	ATM	3.0"Hg
	9460	Unused					
	9468						

** This site is a site contaminated with aged JP-4 jet fuel
Any questions call Al Pollack 614 - 424 - 3753.

Relinquished By: (Signature) Date/Time [signature] 8/15/95 Print Name
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time [signature] ATL 8/15/95 9:12

Notes:
Modified EPA Method TO-3
GC/FID/PID

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
	Fed Ex	9227469700X	[signature]	8/15/95 9:12	Ambient	Good	Yes No None N/A	9508100

LUBRICATION ANALYSTS, INC.
P.O. BOX 3427
1604 WEST OAKRIDGE DRIVE
ALBANY, GA 31706
(912) 435-6826

ANALYTICAL REPORT

DATE: AUGUST 4, 1995

TO: MR. ERIC DRESCHER
BATTELLE MEMORIAL INSTITUTE
505 KING AVENUE
COLUMBUS, OHIO 43201-2693

SUBJECT: (05) WATER SAMPLES SUBMITTED FOR TPH (PURGABLE JET FUEL) ANALYSIS

ORIGIN: ROBINS AFB - BIOSLURPER
SAMPLE DATE: 08/03/95
RECEIVED IN LAB: 08/03/95

METHODS: 5030/8015 (GAS CHROMATOGARAPH - FLAME IONIZATION)

DETECTION LIMITS: 0.5 PPM

RESULTS:

LAB #	SAMPLE I.D.	TPH JET FUEL (PPM)	
8073	R1 - H20 - 1	22.2	OWS
8074	R1 - H20 - 2	29.4	1500 gal tank
8075	R1 - H20 - 2(DUPLICATE)	31.4	
8076	R1 - H20 - 3	19.9	After Clay #2
8077	R1 - H20 - 4	ND	After Carbon #2

COMMENTS: ND = NONE DETECTED

RESPECTFULLY SUBMITTED,

Brad Williams
BRAD WILLIAMS, LAB DIRECTOR
BW/lk

REVIEWED BY,

CB

LUBRICATION ANALYSTS, INC.
P.O. BOX 3427
1604 WEST OAKRIDGE DRIVE
ALBANY, GA 31706
(912) 435-6826

ANALYTICAL REPORT

DATE: AUGUST 4, 1995

TO: MR. ERIC DRESCHER
BATTELLE MEMORIAL INSTITUTE
505 KING AVENUE
COLUMBUS, OHIO 43201-2693

SUBJECT: (05) WATER SAMPLES SUBMITTED FOR BTEX ANALYSIS

ORIGIN: ROBINS AFB - BIOSLURPER
SAMPLE DATE: 08/03/95
RECEIVED IN LAB: 08/03/95

METHODS: 602 (GAS CHROMATOGARAPH - PHOTOIONIZATION)

DETECTION LIMITS: 0.5 ppb on all constituents (INSTRUMENT DETECTION) SPIKE RECOVERY 99.2%

RESULTS:

LAB #	SAMPLE I.D.	B-T-E-X	(ppb)
8073	R1 - H20 - 1	BENZENE	131.9
		TOLUENE	91.9
		ETHYLBENZENE	91.9
		XYLENES	739.2
8074	R1 - H20 - 2	BENZENE	302.9
		TOLUENE	331.6
		ETHYLBENZENE	126.1
		XYLENES	734.3
8075	R1 - H20 - 2 DUPLICATE	BENZENE	268.6
		TOLUENE	309.3
		ETHYLBENZENE	122.8
		XYLENES	884.9
8076	R1 - H20 - 3	BENZENE	222.4
		TOLUENE	184.6
		ETHYLBENZENE	42.9
		XYLENES	274.8

BTEX ANALYSES
BATTELE MEMORIAL INSTITUTE
PAGE 2

LAB #	SAMPLE I.D.	B-T-E-X	(ppb)
8077	R1 - H20 - 4	BENZENE	ND
		TOLUENE	ND
		ETHYLBENZENE	ND
		XYLENES	ND

COMMENTS: ND = NONE DETECTED

RESPECTFULLY SUBMITTED,

Brad Williams

BRAD WILLIAMS, LAB DIRECTOR
BW/lk

REVIEWED BY,

Bew

LUBRICATION ANALYSTS, INC.
P.O. BOX 3427
1604 WEST OAKRIDGE DRIVE
ALBANY, GA 31706
(912) 435-6826

ANALYTICAL REPORT

DATE: AUGUST 16, 1995

TO: MR. ERIC DRESCHER
BATTELLE MEMORIAL INSTITUTE
505 KING AVENUE
COLUMBUS, OHIO 43201-2693

SUBJECT: (06) WATER SAMPLES SUBMITTED FOR TPH (PURGABLE JET FUEL) ANALYSIS

ORIGIN: ROBINS AFB - BIOSLURPER
SAMPLE DATE: 08/11/95
RECEIVED IN LAB: 08/15/95

METHODS: 5030/8015 (GAS CHROMATOGARAPH - FLAME IONIZATION)

DETECTION LIMITS: 0.5 PPM

RESULTS:

LAB #	SAMPLE I.D.	TPH JET FUEL (PPM)	
8227	R2 - H20 - 1	45.9	OWS
8228	R2 - H20 - 2	36.0	1500 gal tank
8229	R2 - H20 - 2(DUPLICATE)	90.2	
8230	R2 - H20 - 3	21.6	After Clay #2
8031	R2 - H20 - 4	ND	After Carbon #2
8032	R2-H20-4(DUPLICATE)	ND	

COMMENTS: ND = NONE DETECTED

RESPECTFULLY SUBMITTED,

Brad Williams

BRAD WILLIAMS, LAB DIRECTOR
BW/cb

REVIEWED BY,

CB

LUBRICATION ANALYSTS, INC.
P.O. BOX 3427
1604 WEST OAKRIDGE DRIVE
ALBANY, GA 31706
(912) 435-6826

ANALYTICAL REPORT

DATE: AUGUST 16, 1995

TO: MR. ERIC DRESCHER
BATTELLE MEMORIAL INSTITUTE
505 KING AVENUE
COLUMBUS, OHIO 43201-2693

SUBJECT: (06) WATER SAMPLES SUBMITTED FOR BTEX ANALYSIS

ORIGIN: ROBINS AFB - BIOSLURPER
SAMPLE DATE: 08/11/95
RECEIVED IN LAB: 08/15/95

METHODS: 602 (GAS CHROMATOGARAPH - PHOTOIONIZATION)

DETECTION LIMITS: 0.5 ppb on all constituents (INSTRUMENT DETECTION) SPIKE RECOVERY 99.2%

RESULTS:

LAB #	SAMPLE I.D.	B-T-E-X	(ppb)
8227	R2 - H20 - 1	BENZENE	185.8
		TOLUENE	51.6
		ETHYLBENZENE	391.9
		XYLENES	580.4
8228	R2 - H20 - 2	BENZENE	99.1
		TOLUENE	47.3
		ETHYLBENZENE	ND
		XYLENES	144.9
8229	R2 - H20 - 2(DUPLICATE)	BENZENE	107.5
	DUPLICATE	TOLUENE	58.2
		ETHYLBENZENE	ND
		XYLENES	205.8
8230	R2 - H20 - 3	BENZENE	361.0
		TOLUENE	304.8
		ETHYLBENZENE	91.8
		XYLENES	568.7

LAB #	SAMPLE I.D.	B-T-E-X	(ppb)
8231	R2 - H20 - 4	BENZENE	ND
		TOLUENE	ND
		ETHYLBENZENE	ND
		XYLENES	ND
8232	R2 - H20 - 4(DUPLICATE)	BENZENE	ND
		TOLUENE	ND
		ETHYLBENZENE	ND
		XYLENES	ND

RESPECTFULLY SUBMITTED,

Brad Williams

BRAD WILLIAMS, LAB DIRECTOR
BW/cb

REVIEWED BY,

Cb

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. ROBINS - 2

Proj. No. G462201-ROBISL1

Project Title ROBINS AFB - BIOSLURPER

SAMPLERS: (Signature) E. Drescher / K. A. Fields

DATE	TIME	SAMPLE I.D.	TPH-PURGEABLE	TPH-EXTRACTABLE	BTEX	Container No.	Number of Containers	Remarks
8/1/95	11:00 AM	RI - H₂O - 1	X	X	X		1	[illegible] 8023
*		RI - H₂O - 2	X		X		1	[illegible] 8077
*		RI - H₂O - 2 - DUPLICATE	X		X		1	8025
		RI - H₂O - 3	X		X		1	[illegible] 8076
*		RI - H₂O - 4	X		X		1	[illegible] 8077

** PLEASE DO THE ANALYSIS PER 24-HR TURNAROUND TIME
** FAX A COPY OF THE ANALYTICAL RESULTS BY 12:00 PM - 8/4/95 TO 912-926-9642

Relinquished by: (Signature)	Date/Time		Received by: (Signature)	Relinquished by: (Signature)	Date/Time		Received by: (Signature)
Keith Fields	8/3/95	4:48	Cleo L. Braswell				

Relinquished by: (Signature)	Date/Time		Received by: (Signature)	Relinquished by: (Signature)	Date/Time		Received by: (Signature)

Relinquished by: (Signature)	Date/Time		Received for Laboratory by: (Signature)	Date/Time		Remarks

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. ROBINS - 02

Proj. No.	Project Title
G4L-2201-30B15(?)	BIOSLURPER - ROBINS AFB

SAMPLERS: (Signature) E. Drescher

DATE	TIME	SAMPLE I.D.	TPH (Purgeable)	BTEX	SAMPLE TYPE (√)	Container No.	Number of Containers	Remarks
8/11/95	-	R2 - H_2O - 1	X	X	#8227		1	OWS
8/11/95	-	R2 - H_2O - 2	X	X	8228		1	1500
8/11/95	-	R2 - H_2O - 2 DUPLICATE	X	X	8229		1	1500
8/11/95	-	R2 - H_2O - 3	X	X	8230		1	~~CAR~~ CLAY # 2
8/11/95	-	R2 - H_2O - 4	X	X	8231		1	CARB # 2
8/12/95	-	R2 - H_2O - 4 DUPLICATE	X	X	8232		1	CARB # 2
~~8/ /95~~	-	~~R2 - H_2O~~						

* PLEASE ANALYZE SAMPLES FOR 24-hr turnaround. FAX RESULTS TO ERIC DRESCHER (EMR) 912-926-9642

Relinquished by: (Signature)	Date/Time		Received by: (Signature)	Relinquished by: (Signature)	Date/Time		Received by: (Signature)
E. Drescher	8/14/95	3:00	fed. ex.				
fed. ex.	8/15/95	9:30	Melanie Riegle				

Relinquished by: (Signature)	Date/Time		Received for Laboratory by: (Signature)	Date/Time		Remarks

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: Bio Slurper Robins AFB
Phone: (614) 424-3088
Attn: Eric Drescher

Sampled: 07/22-23/95 Received: 07/25/95 Analyzed: 07/31/95
Matrix: [X] Soil [ ] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit	
R1-MPA-7.0'-7.5' /BMI072595-01	TPH (Purgeable)	31,000	1,000	mg/Kg
	Benzene	13,000	2,000	ug/Kg
	Toluene	19,000	2,000	ug/Kg
	Total Xylenes	190,000	2,000	ug/Kg
	Ethylbenzene	31,000	2,000	ug/Kg
R1-MPA-7.5'-8.0' /BMI072595-02	TPH (Purgeable)	19,000	1,000	mg/Kg
	Benzene	14,000	2,000	ug/Kg
	Toluene	15,000	2,000	ug/Kg
	Total Xylenes	140,000	2,000	ug/Kg
	Ethylbenzene	24,000	2,000	ug/Kg
R2-MPA-6.0'-6.5' /BMI072595-03	TPH (Purgeable)	430	100	mg/Kg
	Benzene	ND	200	ug/Kg
	Toluene	1,300	200	ug/Kg
	Total Xylenes	8,200	200	ug/Kg
	Ethylbenzene	1,300	200	ug/Kg
R2-MPA-6.5'-7.0' /BMI072595-04	TPH (Purgeable)	410	100	mg/Kg
	Benzene	ND	200	ug/Kg
	Toluene	1,500	200	ug/Kg
	Total Xylenes	8,900	200	ug/Kg
	Ethylbenzene	1,400	200	ug/Kg

UST 7072

SS010

ND - Not Detected

Approved by: Roger L. Scholl Date: 8/3/95
Roger L. Scholl, Ph.D.
Laboratory Director

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date : 8/15/95
Client : ALP-855
Taken by: CLIENT
Report : 13836
PO# :

Page: 1

Sample	Collected Date	Time	MOISTURE CONTENT %	PARTICLE SIZE CLASSIF. HYDROMETER	DENSITY G/CM3	POROSITY %		
BMI072595-01 - R1-MPA-7.0-7.5'	7/22/95	:	9.6%	YES	1.21	45.7%		
BMI072595-03 - R2-MPA-6.0-6.5'	7/23/95	:	17.2%	YES	1.83	69.1%		

Approved By: [signature]

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

November 27, 1995

TO: Alpha Analytical

FROM: Sierra Environmental Monitoring, Inc.

RE: Particle Size Distribution Analysis for Samples:

SEM 9507-0719 AAI BMI072595-01
SEM 9507-0720 AAI BMI072595-03

As per your request, we have performed particle size analysis on the samples submitted to our laboratory. Test results are as follows:

	BMI072595-01	BMI072595-03
% Sand	91.0	86.0
% Silt	4.0	4.0
% Clay	5.0	10.0

The sample was passed through a #10 sieve prior to analysis as per procedure. All results are based on oven dry sample weights.

We appreciate this opportunity to provide our laboratory testing services. If you have any questions or require further testing, please feel free to contact us at your convenience.

Sincerely,
SIERRA ENVIRONMENTAL MONITORING, INC.

John Seher
Laboratory Manager

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date :
Client : ALP-855
Taken by: CLIENT
Report : 13836
PO# :

Ammended Report: Previous report contained an error in calculation of the soil porosity.

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Laboratory
Analysis Report

Sierra
Environmental
Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date : 9/20/95
Client : ALP-855
Taken by: CLIENT
Report : 13836
PO# :

Sample	Collected Date	Collected Time	MOISTURE CONTENT %	PARTICLE SIZE CLASSIF. HYDROMETER	DENSITY G/CM3	POROSITY %		
BMI072595-01 - R1-MPA-7.0-7.5'	7/22/95	:	9.6%	YES	1.21	54.3%		
BMI072595-03 - R2-MPA-6.0-6.5'	7/23/95	:	17.2%	YES	1.83	30.9%		

Approved By: [signature]

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

William F. Pillsbury
President

John C. Seher
Manager

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date : 8/17/95
Client : ALP-855
Taken by: CLIENT
Report : 13965
PO# :

Sample	Collected Date	Time	FLASHPOINT DEG C					
BMI080895-01 - R1-FUEL-1	8/04/95	:	49 F					

Approved By:

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Laboratory
Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date :
Client : ALP-855
Taken by: CLIENT
Report : 13965
PO# :

ANALYSIS PERFORMED BY UNITED TESTING GROUP

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

Purgeable TPH Matrix Spike/Matrix Spike Duplicate Recovery
EPA Method 5030/8015

Lab Name: Alpha Analytical, Inc.

Client ID: 18-MW-09

Date Analyzed: 08/16/95

AAI Lab ID: BMI081295-02

Compound	Spike Added (mg/L)	Sample Conc. (mg/L)	MS Conc. (mg/L)	MS % Recovery	Adivisory Limits % Recovery
Gasoline	10	0	7.8	78	50-150

Compound	Spike Added (mg/L)	MSD Conc. (mg/L)	MSD % Recovery	% RPD	Advisory Limits % RPD	Advisory Limits % Recovery
Gasoline	10	7.5	75	4	50	50-150

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. BIOSLURPER - ROBINS - 0?

Proj. No.	Project Title
G462201-30B1501	BIOSLURPER - ROBINS AFB

SAMPLERS: (Signature) Eric Drescher / Marty Wheeler

DATE	TIME	SAMPLE I.D.	BTEX (PURGEABLE)	TPH	BULK DENSITY	MOISTURE CONTENT	PARTICLE SIZE	POROSITY	Container No.	Number of Containers	Remarks
7/22/95		R1 - MPA - 7.0' - 7.5'	X	X	X	X	X	X		1	
7/22/95		R1 - MPA - 7.5' - 8.0'	X	X						1	
7/23/95		R2 - MPA - 6.0 - 6.5'	X	X	X	X	X	X		1	
7/23/95		R2 - MPA - 6.5 - 7.0'	X	X						1	

Relinquished by: (Signature)	Date/Time		Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Eric Drescher	7/24/95	8:00 AM				
Relinquished by: (Signature)	Date/Time		Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[signature]	7/26/95	336 pm				
Relinquished by: (Signature)	Date/Time		Received for Laboratory by: (Signature)	Date/Time		Remarks
			[signature]	7/25/95	1000	

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

GA.

Page # 1 of 1

Billing Information:
Name
Address
City, State, Zip
Phone Number

Client Name: Battelle
Address
City, State, Zip

P.O. #: Kelly/Harper Robins AFB
Phone #: (912) 424 3088
Report Attention: Eric Meadows
Sampled by: Client

Analyses Required: BTXE, TPH G/D, Bulk Density, Moisture Content, Particle Size, Porosity

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	BTXE	TPH G/D	Bulk Density	Moisture Content	Particle Size	Porosity				Remarks
	7/22	SO	BAT072595-01	R1-MPA-7.0'-7.5'	1	X	X	X	X	X	X				Bruce Sellers
	✓	✓	02	R1-MPA-7.5'-8.0'	1	X	X								Georgia St
	7/23	✓	03	R2-MPA-6.0'-6.5'	1	X	X	X	X	X	X				
	✓	✓	04	R2-MPA-6.5'-7.0'	1	X	X								
															mail
															(912) 956 3311

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	Linda Lerner	Linda LERNER	AAI	7/25/95	1000
Relinquished by	Darin Hussey	DARIN HUSSEY	AAI	7/26/95	3:36pm
Received by	[illegible]	[illegible]	SCM	7/26/95	1536
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - OTher

Alpha Analytical, Inc.
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(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#:
Phone: (614) 424-6199
Attn: Al Pollock

Sampled: 08/05-06/95 Received: 08/08/95 Analyzed: 08/11/95

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
R1-OutH20-1 /BMI080895-02	TPH (Gasoline)	ND	0.50 mg/L
	Benzene	ND	1.0 ug/L
	Toluene	ND	1.0 ug/L
	Total Xylenes	ND	1.0 ug/L
	Ethylbenzene	ND	1.0 ug/L
R1-OutH20-2 /BMI080895-03	TPH (Gasoline)	ND	0.50 mg/L
	Benzene	ND	1.0 ug/L
	Toluene	ND	1.0 ug/L
	Total Xylenes	ND	1.0 ug/L
	Ethylbenzene	ND	1.0 ug/L

ND - Not Detected

Approved by: Roger L. Scholl Date: 8/18/95
Roger L. Scholl, Ph.D.
Laboratory Director

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ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#:
Phone: (614) 424-6199
Attn: Al Pollock

Sampled: 08/04/95 Received: 08/08/95 Analyzed: 08/16/95

Matrix: [ ] Soil [ ] Water [X] Other

Analysis Requested: BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
R1-Fuel-1	Benzene	460	350 mg/Kg
/BMI080895-01	Toluene	1,600	350 mg/Kg
	Total Xylenes	7,200	350 mg/Kg
	Ethylbenzene	1,100	350 mg/Kg

Approved by: Roger L. Scholl Date: 8/18/95
Roger L. Scholl, Ph.D.
Laboratory Director

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ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#:
Phone: (614) 424-6199
Attn: Al Pollock

Alpha Analytical Number: BMI080895-01

Client I.D. Number: R1-Fuel-1

Compound	Method	Concentration mg/Kg	Detection Limit mg/Kg	Date Analyzed
Benzene	8240	460	350	08/16/95
Toluene	8240	1,600	350	08/16/95
Total Xylenes	8240	7,200	350	08/16/95
Ethylbenene	8240	1,100	350	08/16/95
C-range Compounds	Method	Percentage of Total (%)	Detection Limit (Not	Date Analyzed
C9<	GC/FID	17.33	NA	08/22/95
C10	GC/FID	28.09	NA	08/22/95
C11	GC/FID	19.14	NA	08/22/95
C12	GC/FID	12.48	NA	08/22/95
C13	GC/FID	10.31	NA	08/22/95
C14	GC/FID	6.60	NA	08/22/95
C15	GC/FID	3.53	NA	08/22/95
C16	GC/FID	1.59	NA	08/22/95
C17>	GC/FID	0.93	NA	08/22/95

Approved by: Roger L. Scholl Date: 8/22/95
Roger L. Scholl, Ph.D.
Laboratory Director

Battelle
Columbus Laboratories

Form No. ROBINS-3

CHAIN OF CUSTODY RECORD

Proj. No. G-1-2201-200501

Project Title

SAMPLERS: (Signature) Erin Dracelin

DATE	TIME	SAMPLE I.D.	SAMPLE TYPE (√) TPH Gas	BTEX	Falling it Fails	Container No.	Number of Containers	Remarks
7/1/95		R1-FUEL-1		X	X		1	
7/5/95		R1-OUTH₂O-1	X	X			1	
7/6/95		R1-OUTH₂O-2	X	X			1	
		** PLEASE SEND RESULTS						
		TO A. POLLACK						
		BATTELLE						
		505 KING AVE						
		COLUMBUS OH 43201						

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
E. Dracelin	7/7/95 9:00am				

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks
		[illegible signature]	8/8/95 1000	

Page 1 of 1

Billing Information:

Name
Address
City, State, Zip
Phone Number

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Fax (702) 355-0406

Page # 1 of 1

Client Name: Battelle
P.O. #
Address
Phone #
City, State, Zip
Report Attention: Al Pollock
Sampled by: Client

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	BTXE	Boiling Pt. Range	TPH/gas						Remarks
	8/4	OT	BMI080895-01	R1 - Fuel - 1	1	X	X							
	8/5	AQ	02	R1 - OUT H2O - 1	1 Voa	X		X						
	8/6	✓	03	R1 - OUT H2O - 2	1 Voa	X		X						Kuy Rei Battelle 03

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by		Linda LERNER	AAI	8/8/95	1000
Relinquished by		Linda LERNER	AAI	8/9/95	1555
Received by		Jim Ollerton	SEM	8/9/95	3:55
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

†Key: [redacted] Aque[redacted] S[redacted]oil [redacted] WA - W[redacted] OT - OThe[redacted]

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Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: Robins AFB Bio Slurper
Phone: (614) 424-6199
Attn: Eric Drescher

Sampled: 08/07-10/95 Received: 08/25/95 Analyzed: 08/28/95

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
R2-OUT H2O-1 /BMI082595-02	TPH (Purgeable)	ND	0.50 mg/L
	Benzene	ND	1.0 ug/L
	Toluene	ND	1.0 ug/L
	Total Xylenes	ND	1.0 ug/L
	Ethylbenzene	ND	1.0 ug/L
R2-OUT H2O-2 /BMI082595-03	TPH (Purgeable)	ND	0.50 mg/L
	Benzene	ND	1.0 ug/L
	Toluene	ND	1.0 ug/L
	Total Xylenes	ND	1.0 ug/L
	Ethylbenzene	ND	1.0 ug/L
R1-OUT H2O-3 /BMI082595-04	TPH (Purgeable)	ND	0.50 mg/L
	Benzene	ND	1.0 ug/L
	Toluene	ND	1.0 ug/L
	Total Xylenes	ND	1.0 ug/L
	Ethylbenzene	ND	1.0 ug/L

ND - Not Detected

Approved by: Roger L. Scholl Date: 9/13/95
Roger L. Scholl, Ph.D.
Laboratory Director

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ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: Robins AFB-Bioslurper
Phone: (614) 424-6122
Attn: Eric Drescher

Alpha Analytical Number: BMI082595-05

Client I.D. R2-Fuel-1

Compound	Method	Concentration ug/Kg	Detection Limit ug/Kg	Date Analyzed
Benzene	8240	ND	720,000	08/28/95
Toluene	8240	1,400,000	720,000	08/28/95
Total Xylenes	8240	18,000,000	720,000	08/28/95
Ethylbenene	8240	2,200,000	720,000	08/28/95
C-range Compounds	Method	Percentage of Total	Detection Limit (Not Applicable)	Date Analyzed
C9<	GC/FID	38.7	NA	09/12/95
C10	GC/FID	19.3	NA	09/12/95
C11	GC/FID	15.6	NA	09/12/95
C12	GC/FID	11.1	NA	09/12/95
C13	GC/FID	8.3	NA	09/12/95
C14	GC/FID	3.9	NA	09/12/95
C15	GC/FID	1.9	NA	09/12/95
C16	GC/FID	063	NA	09/12/95
C17>	GC/FID	0.45	NA	09/12/95

Approved by: Roger L. Scholl

Date: 9/13/95

Roger L. Scholl, Ph.D.
Laboratory Director

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WATER VOLATILE MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

EPA Method 624/8240

Lab Name: Alpha Analytical, Inc.

AAI Lab ID: BMI081295-02

Date Analyzed: 08/16/95

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	MS Concentration (ug/L)	MS Percent Recovery #	QC Limits Recovery
Benzene	50	0	39	78	76-127
Toluene	50	0	45	90	76-125

Compound	Spike Added (ug/L)	MSD Concentration (ug/L)	MSD Percent Recovery #	Percent RPD #	QC Limits RPD	QC Limits Recovery
Benzene	50	47	94	19*	11	76-127
Toluene	50	57	114	24*	13	76-125

\# - Column to be used to flag recovery and RPD values with an asterisk
* - Values outside of QC limits

RPD: 2 out of 2 outside of limits
Spike Recovery: 0 out of 4 outside of limits

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. ROBINS - 4

Proj. No. G462201-30B1501

Project Title: ROBINS AFB- BIOSLURPER

SAMPLERS: (Signature) Eric Drescher

DATE	TIME	SAMPLE I.D.	BTEX	BOILING PT RANGE	TPH (as jet fuel)	Container No.	Number of Containers	Remarks
8/10/95	-	R2 - OUTH2O - 1	X		X		1	
	-	R2 - OUTH2O - 1 DUP	X		X		1	
8/11/95	-	R2 - OUTH2O - 2	X		X		1	
	-	R2 - OUTH2O - 2 DUP	X		X		1	
		~~R2 - OUTH2O~~						
8/7/95	-	R1 - OUTH2O - 3	X		X		1	
	-	R1 - OUTH2O - 3 DUP	X		X		1	
8/10/95	-	R2 - FUEL - 1	X	X	X		1	

~~**~~ DO NOT ANALYZE THE DUPLICATE SAMPLES UNLESS THE ORIGINALS CONTAIN BTEX AND/OR TPH. THANKS.

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Eric Drescher	8/21/95				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
		[illegible signature]	8/25/95 1030		

Billing Information:

Name

Address

City, State, Zip

Phone Number

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Client Name: Battelle

P.O. #: Robins AFB

Address

Phone #

City, State, Zip

Report Attention: Eric Drescher

Sampled by: Client

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	BTXE	Boiling Pt. (sim)	TPH GAS							Remarks
	8/10	AQ	DMI082595-02	R2-OUTH2O-1 + Dup*A	2	X		X							*Only Run the
	8/11	✓	03	R2-OUTH2O-2 + Dup*B	2	X		X							Dup. samples if
	8/7	✓	04	R1-OUTH2O-3 + Dup*C	2	X		X							BTXE GAS is
	8/10	OT	05	R2-Fuel-1	1	X	X	X							Detected. product

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	[signature]	Linda Lerner	AAI	8/25/95	1030
Relinquished by					
Received by					
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - OTher

APPENDIX C

SYSTEM CHECKLISTS

SITE UST 70/72

Checklist for System Shakedown

Site: UST 70/72

Date: 7/24/95

Operator's Initials: ED/MW

Equipment	Check if Okay	Comments
Liquid Ring Pump	X	5.0-hp liquid ring pump has failed, have sent for a new liquid ring pump
Aqueous Effluent Transfer Pump	✓	
Oil/Water Separator	✓	
Vapor Flowmeter	✓	
Fuel Flowmeter	✓	
Water Flowmeter	✓	
Emergency Shut off Float Switch Effluent Transfer Tank	✓	
Analytical Field Instrumentation GasTector™ O_2/CO_2 Analyzer TraceTector™ Hydrocarbon Analyzer Oil/Water Interface Probe Magnehelic Boards Thermocouple Thermometer	✓ ✓ ✓ ✓ ✓	Calibrated GasTector Analyzer w/ 10% O_2/CO_2 Calibration Gas

SITE SS010

Checklist for System Shakedown

Site: SS010

Date: 8/9/95

Operator's Initials: ED/KF

Equipment	Check if Okay	Comments
Liquid Ring Pump	✓	
Aqueous Effluent Transfer Pump	✓	
Oil/Water Separator	✓	
Vapor Flowmeter	✓	
Fuel Flowmeter	✓	
Water Flowmeter	✓	
Emergency Shut off Float Switch Effluent Transfer Tank	✓	
Analytical Field Instrumentation	✓	Calibrated all Tectors w/ Calibration gas
GasTector™ O_2/CO_2 Analyzer	✓	
TraceTector™ Hydrocarbon Analyzer	✓	
Oil/Water Interface Probe	✓	
Magnehelic Boards	✓	
Thermocouple Thermometer	✓	

APPENDIX D

DATA SHEETS FROM THE SHORT-TERM PILOT TEST

SITE UST 70/72

FIGURE 1

LIQUID DISCHARGE LOG

PROJECT NAME: ROBINS AFB - BIOSLURPER

PROJECT NUMBER: G462201-30B1501

DATE OF DISCHARGE: 8/2/95 - 8/8/95

TIME OF DISCHARGE: 8:00 AM 8/2/95 - 8/8/95 2:30 pm

DISCHARGED BY: ERIC DRESCHER (BATTELLE)

NAME OF TRANSPORTER: PVC PIPING 1"

DESCRIPTION OF CONTAMINANTS: NONE TPH 0 ppm (ND) BTEX 0 ppm (ND)

DRUM NUMBER	SOURCE	VOLUME OF LIQUIDS (gallons)
BY SEWER LINE	UST SITE 70/72	Skimmer = 1420 gal
	WELL EA-2	Bioslurper = 5425 gal
		Drawdown = 1910 gal
		Total = 8755 gal

Baildown Test Record Sheet

Site: ROBINS AFB - SITE UST 70/72

Well Identification: EA-2

Well Diameter (OD/ID): 4"

Date at Start of Test: 7/20/95

Sampler's Initials: ED/MW

Time at Start of Test: 8:30

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
8.50	6.67	1.83	5.8 L.

Test Data

	Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
TIME 8:50 7/20/95	0:00	8.09	6.78	1.31
	0:10	8.35	6.67	1.68
	0:20	8.38	6.67	1.71
	0:30	8.40	6.67	1.73
11:54	3:04	8.45	6.67	1.78
16:16	7:26	8.47	6.67	1.80
7/21/95 6:56am	22:06	8.50	6.67	1.83

UST 70/72 Site - Robins AFB

Test : Skimmer Pump Test #1

Time (min)	Time (hr)	LNAPL Recovery Col. (gal)	LNAPL Recovery Total (gal)	Total LNAPL Flowrate (gpm)	Total LNAPL Flowrate (gph)	Groundwater Removal Rate Col. (gal)	Groundwater Removal Rate Total (gal)	Total GW Flowrate (gpm)	Total GW Flowrate (gph)	Time Period GW Flowrate (gpm)	Diff. Stack Pressure (in H_2O)	Stack Temperature (deg C)	Pump Head Vacuum (in Hg)	Ambient Temperature (deg C)	Relative Humidity (%)	Barometric Pressure (in Hg)
0	0	0	0	0.00	0.00	0	0.0	0.00	0.00	0.00	0.03	37.4	26	34.2	55	29.4
60	1	1.2	1.2	0.02	1.20	35	35.0	0.58	35.00	0.58						
150	2.5	1.2	2.4	0.02	0.96	33	68.0	0.45	27.20	0.37						
225	3.75	1.2	3.6	0.02	0.96	37	105.0	0.47	28.00	0.49	0.015	41.2	25.5			
330	5.5	1.3	4.9	0.01	0.89	70	175.0	0.53	31.82	0.67						
540	9	2.6	7.5	0.01	0.83	100	275.0	0.51	30.56	0.48						
960	16	4.5	12	0.01	0.75	215	490.0	0.51	30.63	0.51	0.045	40.5	26			
1110	18.5	0.5	12.5	0.01	0.68	90	580.0	0.52	31.35	0.60						
1800	30	4.3	16.8	0.01	0.56	380	960.0	0.53	32.00	0.55	0.03	38.6	24.5	35.5	30	29.2
1950	32.5	0.7	17.5	0.01	0.54	110	1070.0	0.55	32.92	0.73						
2160	36	0.4	17.9	0.01	0.50	170	1240.0	0.57	34.44	0.81	0.02	41.2	25			
2325	38.75	0.1	18	0.01	0.46	120	1360.0	0.58	35.10	0.73						
2415	40.25	0.2	18.2	0.01	0.45	60	1420.0	0.59	35.28	0.67	0.035	41.6	25			

Test : Skimmer Pump Test #2

Time (min)	Time (hr)	LNAPL Recovery Col. (gal)	LNAPL Recovery Total (gal)	Total LNAPL Flowrate (gpm)	Total LNAPL Flowrate (gph)	Groundwater Removal Rate Col. (gal)	Groundwater Removal Rate Total (gal)	Total GW Flowrate (gpm)	Total GW Flowrate (gph)	Time Period GW Flowrate (gpm)	Diff. Stack Pressure (in H_2O)	Stack Temperature (deg C)	Pump Head Vacuum (in Hg)	Ambient Temperature (deg C)	Relative Humidity (%)	Barometric Pressure (in Hg)
0	0	0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.05	39.5	26	36.3	25	29
90	1.5	0.9	0.90	0.01	0.60	51.0	51.0	0.57	34.00	0.57						
270	4.5	1.4	2.30	0.01	0.51	94.0	145.0	0.54	32.22	0.52	0.04	40.1	25.5			
480	8	1.4	3.70	0.01	0.46	114.0	259.0	0.54	32.38	0.54						
1290	21.5	0.7	4.40	0.00	0.20	418.0	677.0	0.52	31.49	0.52						
1335	22.25	0.2	4.60	0.00	0.21	20.0	697.0	0.52	31.33	0.44	0.015	41.2	22.5			

UST 70/72 Site - Robins AFB

Test : Vacuum Enhancement Pump Test

Time (min)	Time (hr)	LNAPL Recovery Col. (gal)	LNAPL Recovery Total (gal)	Total LNAPL Flowrate (gpm	Total LNAPL Flowrate (gph)	Groundwater Removal Rate Col. (gal)	Groundwater Removal Rate Total (gal)	Total GW Flowrate (gpm)	Total GW Flowrate (gph)	Time Period GW Flowrate (gpm)	Diff. Stack Pressure (in H2O)	Stack Temperature (deg C)	Pump Head Vacuum (in Hg)	Well Head Pressure (in H2O)	Ambient Temperature (deg C)	Relative Humidity (%)	Barometric Pressure (in Hg)
0	0	0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.05	40.5	26	16	37.3	45	29.5
60	1	2.4	2.40	0.04	2.40	62.0	62.0	1.03	62.00	1.03							
90	1.5	1.2	3.60	0.04	2.40	30.0	92.0	1.02	61.33	1.00							
120	2	1.2	4.80	0.04	2.40	32.0	124.0	1.03	62.00	1.07	0.035		24.5	15.5			
150	2.5	1.2	6.00	0.04	2.40	30.0	154.0	1.03	61.60	1.00							
210	3.5	2.4	8.40	0.04	2.40	61.0	215.0	1.02	61.43	1.02							
300	5	3.9	12.30	0.04	2.46	90.0	305.0	1.02	61.00	1.00							
405	6.75	4.8	17.10	0.04	2.53	120.0	425.0	1.05	62.96	1.14	0.05	41.3	26.5	17			
510	8.5	4.9	22.00	0.04	2.59	107.0	532.0	1.04	62.59	1.02							
690	11.5	7.8	29.80	0.04	2.59	208.0	740.0	1.07	64.35	1.16							
1470	24.5	35.3	65.10	0.04	2.66	735.0	1475.0	1.00	60.20	0.94	0.05	39.7	26.5	16.5	40.2	60	28.8
1650	27.5	5.6	70.70	0.04	2.57	185.0	1660.0	1.01	60.36	1.03							
1740	29	2.8	73.50	0.04	2.53	105.0	1765.0	1.01	60.86	1.17							
1980	33	7.5	81.00	0.04	2.45	255.0	2020.0	1.02	61.21	1.06	0.02		23	15			
2070	34.5	2.8	83.80	0.04	2.43	105.0	2125.0	1.03	61.59	1.17							
2130	35.5	1.9	85.70	0.04	2.41	65.0	2190.0	1.03	61.69	1.08							
2880	48	23.5	109.20	0.04	2.28	775.0	2965.0	1.03	61.77	1.03	0.045	38.6	25.5	16	39.7	70	29
2970	49.5	2.5	111.70	0.04	2.26	90.0	3055.0	1.03	61.72	1.00							
3060	51	2.5	114.20	0.04	2.24	100.0	3155.0	1.03	61.86	1.11							
3300	55	6.7	120.90	0.04	2.20	255.0	3410.0	1.03	62.00	1.06	0.015	42.2	22.5	14.8			
3390	56.5	2.5	123.40	0.04	2.18	95.0	3505.0	1.03	62.04	1.06							
4155	69.25	21.3	144.70	0.03	2.09	775.0	4280.0	1.03	61.81	1.01							
4320	72	4.7	149.40	0.03	2.08	170.0	4450.0	1.03	61.81	1.03	0.025	37.6	23.5	15.5	40.5	65	29.4
4530	75.5	5.8	155.20	0.03	2.06	225.0	4675.0	1.03	61.92	1.07							
4680	78	4.2	159.40	0.03	2.04	165.0	4840.0	1.03	62.05	1.10							
4770	79.5	2.5	161.90	0.03	2.04	85.0	4925.0	1.03	61.95	0.94	0.04	41	24.5	16			
5280	88	14.2	176.10	0.03	2.00	300.0	5225.0	0.99	59.38	0.59							
5460	91	5	181.10	0.03	1.99	125.0	5350.0	0.98	58.79	0.69							
5550	92.5	2.5	183.60	0.03	1.98	25.0	5375.0	0.97	58.11	0.28							
5640	94	2.5	186.10	0.03	1.98	50.0	5425.0	0.96	57.71	0.56	0.04	39.5	24.5	16			

UST 70/72 Site - Robins AFB

Test : Drawdown Pump Test

Time (min)	Time (hr)	LNAPL Recovery Col. (gal)	LNAPL Recovery Total (gal)	Total LNAPL Flowrate (gpm	Total LNAPL Flowrate (gph)	Groundwater Removal Rate Col. (gal)	Groundwater Removal Rate Total (gal)	Total GW Flowrate (gpm)	Total GW Flowrate (gph)	Time Period GW Flowrate (gpm)	Diff. Stack Pressure (in H2O)	Stack Temperature (deg C)	Pump Head Vacuum (in Hg)	Ambient Temperature (deg C)	Relative Humidity (%)	Barometric Pressure (in Hg)
0	0	0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.05	38.4	26	39.4	75	29
30	0.5	0.3	0.30	0.01	0.60	50.0	50.0	1.67	100.00	1.67						
90	1.5	0	0.30	0.00	0.20	105.0	155.0	1.72	103.33	1.75						
225	3.75	3.2	3.50	0.02	0.93	260.0	415.0	1.84	110.67	1.93	0.05		26	41.6		
540	9	2.3	5.80	0.01	0.84	505.0	920.0	1.70	102.22	1.60						
570	9.5	0.5	6.30	0.01	0.66	50.0	970.0	1.70	102.11	1.67						
1200	20	4.2	10.50	0.01	0.53	765.0	1735.0	1.45	86.75	1.21						
1320	22	0	10.50	0.01	0.48	175.0	1910.0	1.45	86.82	1.46	0.045	39.5	25.5	40	80	28.6

SITE SS010

FIGURE 1

LIQUID DISCHARGE LOG

PROJECT NAME: ROBINS AFB - BIOSLURPER

PROJECT NUMBER: G462201 - 30B1501

DATE OF DISCHARGE: 8/10/95 - 8/15/95

TIME OF DISCHARGE: 2:00pm 8/10/95 - 2:00 8/15/95

DISCHARGED BY: ERIC DRESCHER (BATTELLE)

NAME OF TRANSPORTER: (SAME)

DESCRIPTION OF CONTAMINANTS: NONE TPH 0 ppm (ND) BTEX 0 ppm (ND)

DRUM NUMBER	SOURCE	VOLUME OF LIQUIDS (gallons)
BY TANK (200 gal)	JP-4 SPILL SITE	1850 8/10
"	"	1400 8/11
"	"	1400 8/12
"	"	1400 8/13
"	"	1400 8/14
"	"	800 8/15
		Total = 8250 gal

Baildown Test Record Sheet

Site: ROBINS AFB - SITE SS010

Well Identification: LIF-3

Well Diameter (OD/ID): 2"

Date at Start of Test: 7/22/95

Sampler's Initials: ED/MW

Time at Start of Test: 2:00pm

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
7.30	6.78	0.52	1.6

Test Data

Sample Collection Time	Depth to ~~Groundwater~~ LNAPL (ft)	Depth to ~~LNAPL~~ H_2O (ft)	LNAPL Thickness (ft)
0:00	6.89	6.91	0.02
0:10	6.87	6.92	0.05
0:20	6.85	6.93	0.08
0:30	6.84	6.93	0.09
1:30	6.83	6.95	0.12
13:45	6.82	6.97	0.15
20:20	6.82	6.97	0.15
23:40	6.81	6.97	0.16
47:15	6.79	7.07	0.28
66:30	6.77	7.22	0.45

Baildown Test Record Sheet

Site: ROBINS AFB - SITE SS010

Well Identification: PZ-1

Well Diameter (OD/ID): 1"

Date at Start of Test: 7/22/95

Sampler's Initials: ED/MW

Time at Start of Test: 9:00

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
4.60	3.90	0.70	0.9

Test Data

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
0:00	4.06	4.05	0.01
0:10	4.09	4.05	0.05
0:20	4.11	4.04	0.07
0:30	4.11	4.03	0.08
1:30	4.20	4.03	0.17
15:00	4.22	4.02	0.20
20:40	4.24	4.02	0.22
24:05	4.27	4.00	0.27
47:20	4.39	3.95	0.44
66:40	4.50	3.95	0.55

Figure 7. Typical Baildown Test Record Sheet

SS010 Site - Robins AFB

Test : Skimmer Pump Test

Time (min)	Time (hr)	LNAPL Recovery Col. (gal)	LNAPL Recovery Total (gal)	Total LNAPL Flowrate (gpm	Total LNAPL Flowrate (gph)	Groundwater Removal Rate Col. (gal)	Groundwater Removal Rate Total (gal)	Total GW Flowrate (gpm)	Total GW Flowrate (gph)	Time Period GW Flowrate (gpm)	Diff. Stack Pressure (in H2O)	Stack Temperature (deg C)	Pump Head Vacuum (in Hg)	Ambient Temperature (deg C)	Relative Humidity (%)	Barometric Pressure (in Hg)
0	0	0	0	0.00	0.00	0	0.0	0.00	0.00	0.00	0.045	39.5	25.5	35.5	65	30
60	1	0	0	0 00	0 00	28	28.0	0.47	28.00	0.47						
105	1.75	0.8	0.8	0 01	0 46	28	56.0	0.53	32.00	0.62						
300	5	0.4	1.2	0 00	0 24	110	166.0	0.55	33.20	0.56						
960	16	0.5	1.7	0 00	0.11	399	565.0	0.59	35.31	0.60	0.015	41.1	22.5			
1740	29	0.2	1.9	0.00	0 07	485	1050.0	0.60	36.21	0.62						
2040	34	0.4	2.3	0 00	0 07	195	1245.0	0.61	36.62	0.65						
2340	39	0.2	2.5	0 00	0 06	180	1425.0	0.61	36.54	0.60	0.03	39.6	24.5	36.3	47	29.5
2550	42.5	0	2.5	0 00	0 06	125	1550.0	0.61	36.47	0.60						

SS010 Site - Robins AFB

Test : Vacuum Enhancement Pump Test

Time (min)	Time (hr)	LNAPL Recovery Col. (gal)	LNAPL Recovery Total (gal)	Total LNAPL Flowrate (gpm	Total LNAPL Flowrate (gph)	Groundwater Removal Rate Col. (gal)	Groundwater Removal Rate Total (gal)	Total GW Flowrate (gpm)	Total GW Flowrate (gph)	Time Period GW Flowrate (gpm)	Diff. Stack Pressure (in H2O)	Stack Temperature (deg C)	Pump Head Vacuum (in Hg)	Well Head Pressure (in H2O)	Ambient Temperature (deg C)	Relative Humidity (%)	Barometric Pressure (in Hg)
0	0	0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.03	39.5	23.5	15.5	38.4	65	30.1
30	0.5	0	0.00	0.00	0.00	35.0	35.0	1.17	70.00	1.17							
90	1.5	1.1	1.10	0.01	0.73	70.0	105.0	1.17	70.00	1.17							
390	6.5	1.2	2.30	0.01	0.35	321.0	426.0	1.09	65.54	1.07							
660	11	0	2.30	0.00	0.21	249.0	675.0	1.02	61.38	0.92							
1620	27	3.3	5.60	0.00	0.21	1019.0	1694.0	1.05	62.74	1.06	0.05	40.1	25.5	16.5	36.7	72	29.8
1920	32	1.2	6.80	0.00	0.21	316.0	2010.0	1.05	62.81	1.05							
3240	54	1.4	8.20	0.00	0.15	1375.0	3385.0	1.04	62.69	1.04							
3360	56	1.9	10.10	0.00	0.18	65.0	3450.0	1.03	61.61	0.54	0.04	40.2	25	18			
4170	69.5	0.4	10.50	0.00	0.15	865.0	4315.0	1.03	62.09	1.07							
4350	72.5	0.4	10.90	0.00	0.15	144.0	4459.0	1.03	61.50	0.80	0.045		26.5	17			
4620	77	0.2	11.10	0.00	0.14	231.0	4690.0	1.02	60.91	0.88							
5145	85.75	0.4	11.50	0.00	0.13	530.0	5220.0	1.01	60.87	1.01	0.045	41	26	17	41.2	78	29.5

SS010 Site - Robins AFB

Test : Drawdown Pump Test

Time (min)	Time (hr)	LNAPL Recovery Col. (gal)	LNAPL Recovery Total (gal)	Total LNAPL Flowrate (gpm	Total LNAPL Flowrate (gph)	Groundwater Removal Rate Col. (gal)	Groundwater Removal Rate Total (gal)	Total GW Flowrate (gpm)	Total GW Flowrate (gph)	Time Period GW Flowrate (gpm)	Diff. Stack Pressure (in H2O)	Stack Temperature (deg C)	Pump Head Vacuum (in Hg)	Ambient Temperature (deg C)	Relative Humidity (%)	Barometric Pressure (in Hg)
0	0	0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.05	39.8	26.5	39.5	65	29.4
120	2	0	0.00	0.00	0.00	185.0	185.0	1.54	92.50	1.54						
360	6	0.25	0.25	0.00	0.04	333.0	518.0	1.44	86.33	1.39						
510	8.5	0	0.25	0.00	0.03	174.0	692.0	1.36	81.41	1.16	0.03		25.5			
1320	22	0	0.25	0.00	0.01	952.0	1644.0	1.25	74.73	1.18						
1560	26	0.25	0.50	0.00	0.02	321.0	1965.0	1.26	75.58	1.34						
1980	33	0	0.50	0.00	0.02	515.0	2480.0	1.25	75.15	1.23	0.04	40.1	26	38.4	74	29

APPENDIX E

SOIL GAS PERMEABILITY TEST RESULTS

SITE UST 70/72

Site: UST 70/72

Blower Type: 7.5HP Liquid Ring Pump

Time (min.)	Monitoring Point A 8 ft. from vent well		
	Green: 3'	Blue: 5'	Red: 7'
0	0.000	0.000	0.000
5	0.010	1.000	1.700
10	0.020	1.500	1.900
35	0.030	1.500	2.100
50	0.030	1.750	2.000
75	0.030	1.750	2.050
140	0.250	1.750	1.950
1510	0.040	2.000	2.100
1685	0.350	1.950	2.100

Time (min.)	Monitoring Point B 37 ft. from vent well		
	Green: 3'	Blue: 5'	Red: 7'
0	0.000	0.000	0.000
5	0.010	0.050	0.250
10	0.050	0.150	0.500
35	0.070	0.270	0.500
50	0.070	0.250	0.500
75	0.070	0.300	0.520
140	0.070	0.230	0.500
1510	0.070	0.320	0.630
1685	0.070	0.250	0.520

Time (min.)	Monitoring Point C 81 ft. from vent well		
	Green: 3'	Blue: 5'	Red: 7'
0	0.000	0.000	0.000
5	0.000	0.000	0.000
10	0.000	0.000	0.000
35	0.000	0.000	0.010
50	0.000	0.000	0.000
75	0.000	0.000	0.000
140	0.000	0.000	0.000
1510	0.000	0.000	0.000
1685	0.000	0.000	0.000

SITE SS010

Site: SS-010 JP-4 Spill Site

Blower Type: 7.5HP Liquid Ring Pump

Time (min.)	Monitoring Point A 12 ft. from vent well		
	Green: 2'	Blue: 4'	Red: 6'
0	0.000	0.000	0.000
1	0.010	0.090	0.100
5	0.090	0.180	0.250
15	0.200	0.500	0.600
30	0.220	0.550	0.600
60	0.250	0.800	1.200
150	0.250	0.850	1.200
860	0.250	0.900	1.200
1535	0.230	0.900	1.250
2820	0.250	0.900	1.250

Time (min.)	Monitoring Point B 25 ft. from vent well		
	Green: 2'	Blue: 4'	Red: 6'
0	0.000	0.000	0.000
1	0.200	0.120	0.150
5	0.160	0.500	0.500
15	0.170	0.550	0.550
30	0.160	0.500	0.500
60	0.170	0.750	0.950
150	0.170	0.800	1.000
860	0.170	0.800	1.000
1535	0.160	0.750	1.000
2820	0.170	0.750	1.050

Time (min.)	Monitoring Point C 38 ft. from vent well		
	Green: 2'	Blue: 4'	Red: 6'
0	0.000	0.000	0.000
1	0.070	0.100	0.100
5	0.130	0.150	0.450
15	0.130	0.170	0.480
30	0.150	0.170	0.550
60	0.160	0.170	0.650
150	0.160	0.170	0.650
860	0.160	0.170	0.650
1535	0.140	0.170	0.650
2820	0.140	0.170	0.650

APPENDIX F

IN SITU RESPIRATION TEST RESULTS

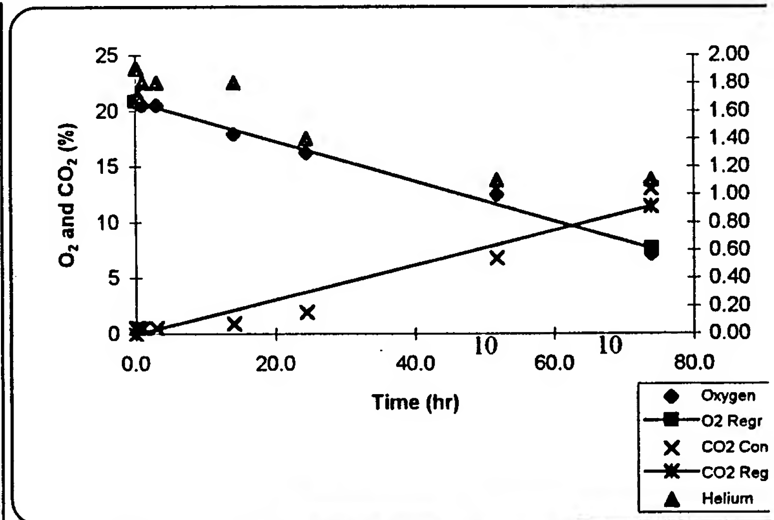
SITE UST 70/72

In Situ Respiration Test

Date: 8/16/95 **Site Name:** UST 70/72 - Robins A

Monitoring Point: R1-MPA-7 **Depth of M.P. (ft):** 7'

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
8/11/95 9:30	0.0	20.90	0.50	1.90
8/11/95 9:40	0.2	20.90	0.50	1.90
8/11/95 9:50	0.3	20.70	0.50	1.70
8/11/95 10:00	0.5	20.70	0.50	1.70
8/11/95 10:30	1.0	20.50	0.50	1.80
8/11/95 12:30	3.0	20.50	0.50	1.80
8/11/95 23:40	14.2	17.90	0.90	1.80
8/12/95 10:00	24.5	16.20	1.90	1.40
8/13/95 13:20	51.8	12.50	6.80	1.10
8/14/95 11:30	74.0	7.10	13.00	1.10



O_2 Utilization Rate

Ko	0.003 %/min
	0.178 %/hr
	4.283 %/day

Regression Lines	O_2	CO_2
Slope	-0.1785	0.1545
Intercept	20.8151	-0.0581
Determination Coef.	0.9927	0.9353
No. of Data Points.	10	10

In Situ Respiration Test

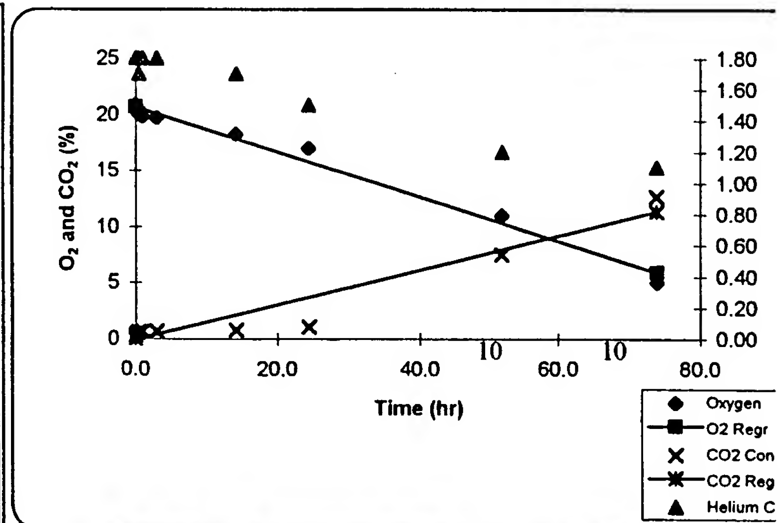
Date: 8/16/95

Site Name: UST 70/72 - Robins A

Monitoring Point: R1-MPB-7

Depth of M.P. (ft): 7'

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
8/11/95 9:30	0.0	20.90	0.30	1.80
8/11/95 9:40	0.2	20.50	0.50	1.80
8/11/95 9:50	0.3	20.50	0.50	1.80
8/11/95 10:00	0.5	20.00	0.60	1.70
8/11/95 10:30	1.0	19.80	0.70	1.80
8/11/95 12:30	3.0	19.70	0.70	1.80
8/11/95 23:40	14.2	18.20	0.80	1.70
8/12/95 10:00	24.5	17.00	1.10	1.50
8/13/95 13:20	51.8	11.00	7.50	1.20
8/14/95 11:30	74.0	5.00	12.70	1.10



O_2 Utilization Rate

Ko	0.003 %/min
	0.199 %/hr
	4.767 %/day

Regression Lines	O_2	CO_2
Slope	-0.1986	0.1540
Intercept	20.6270	-0.0706
Determination Coef.	0.9842	0.9229
No. of Data Points.	10	10

In Situ Respiration Test

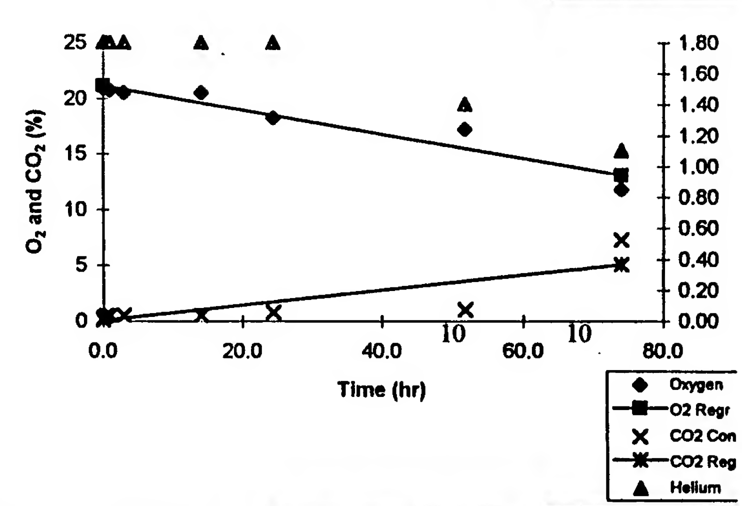
Date: 8/16/95

Site Name: UST 70/72 - Robins A

Monitoring Point: R1-MPC-7

Depth of M.P. (ft): 7'

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
8/11/95 9:30	0.0	20.90	0.30	1.80
8/11/95 9:40	0.2	20.90	0.40	1.80
8/11/95 9:50	0.3	20.90	0.40	1.80
8/11/95 10:00	0.5	20.90	0.50	1.80
8/11/95 10:30	1.0	20.70	0.50	1.80
8/11/95 12:30	3.0	20.50	0.50	1.80
8/11/95 23:40	14.2	20.50	0.50	1.80
8/12/95 10:00	24.5	18.20	0.80	1.80
8/13/95 13:20	51.8	17.20	1.00	1.40
8/14/95 11:30	74.0	11.80	7.30	1.10



O_2 Utilization Rate

Ko	0.002 %/min
	0.108 %/hr
	2.591 %/day

Regression Lines	O_2	CO_2
Slope	-0.1080	0.0679
Intercept	21.0801	0.0688
Determination Coef.	0.9246	0.6789
No. of Data Points.	10	10

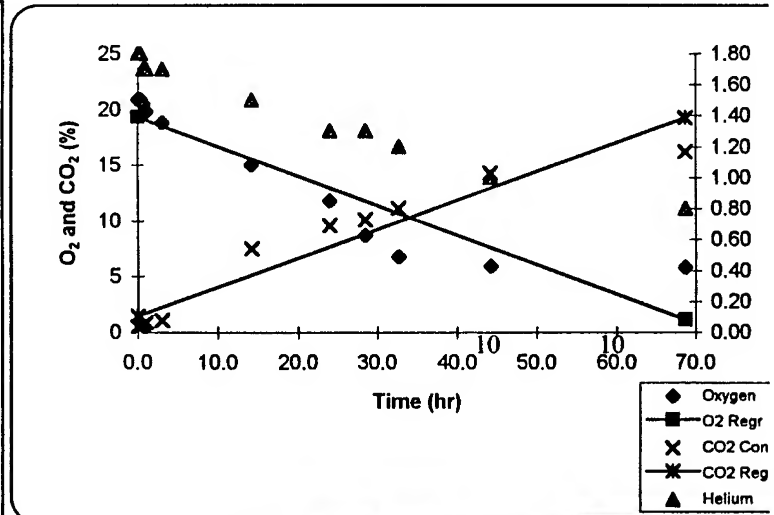
SITE SS010

In Situ Respiration Test

Date: 9/1/95 **Site Name:** SS010 - Robins AFB

Monitoring Point: R2-MPA-4 **Depth of M.P. (ft):** 4'

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
8/17/95 16:30	0.0	20.90	0.50	1.80
8/17/95 16:50	0.3	20.90	0.50	1.80
8/17/95 17:10	0.7	20.50	0.70	1.70
8/17/95 17:30	1.0	19.80	0.90	1.70
8/17/95 19:30	3.0	18.80	1.10	1.70
8/18/95 6:40	14.2	15.00	7.50	1.50
8/18/95 16:30	24.0	11.80	9.60	1.30
8/18/95 21:00	28.5	8.70	10.10	1.30
8/19/95 1:10	32.7	6.80	11.10	1.20
8/19/95 12:45	44.3	5.90	14.30	1.00
8/20/95 13:15	68.8	5.80	16.20	0.80



O_2 Utilization Rate

Ko	
0.004	%/min
0.265	%/hr
6.350	%/day

Regression Lines	O_2	CO_2
Slope	-0.2646	0.2582
Intercept	19.3091	1.4885
Determination Coef.	0.8578	0.9222
No. of Data Points.	11	11

In Situ Respiration Test

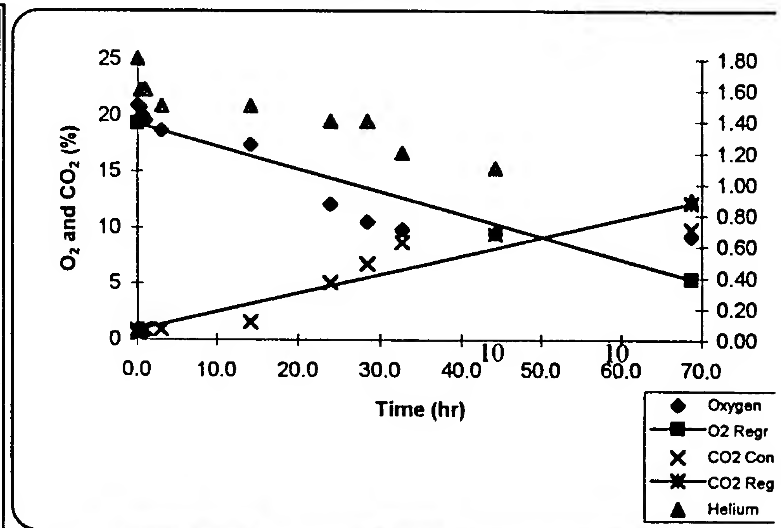
Date: 9/1/95

Site Name: SS010 - Robins AFB

Monitoring Point: R2-MPB-4

Depth of M.P. (ft): 4'

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
8/17/95 16:30	0.0	20.90	0.50	1.80
8/17/95 16:50	0.3	20.70	0.50	1.60
8/17/95 17:10	0.7	20.00	0.80	1.60
8/17/95 17:30	1.0	19.50	0.90	1.60
8/17/95 19:30	3.0	18.60	0.90	1.50
8/18/95 6:40	14.2	17.40	1.60	1.50
8/18/95 16:30	24.0	12.10	5.10	1.40
8/18/95 21:00	28.5	10.50	6.80	1.40
8/19/95 1:10	32.7	9.80	8.70	1.20
8/19/95 12:45	44.3	9.50	9.40	1.10
8/20/95 13:15	68.8	9.20	9.90	0.90



O_2 Utilization Rate

Ko 0.003 %/min
0.201 %/hr
4.834 %/day

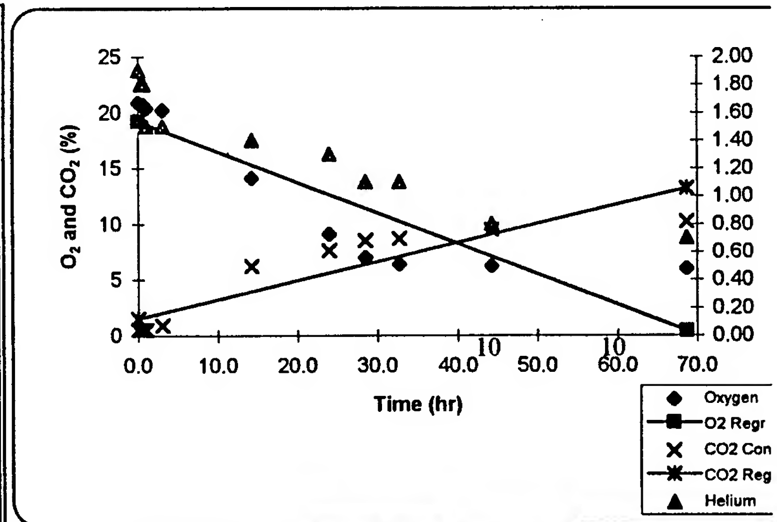
Regression Lines	O_2	CO_2
Slope	-0.2014	0.1647
Intercept	19.2701	0.8461
Determination Coef.	0.8208	0.8865
No. of Data Points.	11	11

In Situ Respiration Test

Date: 9/1/95 **Site Name:** SS010 - Robins AFB

Monitoring Point: R2-MPC-4 **Depth of M.P. (ft):** 4'

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
8/17/95 16:30	0.0	20.90	0.50	1.90
8/17/95 16:50	0.3	20.70	0.50	1.80
8/17/95 17:10	0.7	20.70	0.50	1.80
8/17/95 17:30	1.0	20.40	0.50	1.50
8/17/95 19:30	3.0	20.20	0.90	1.50
8/18/95 6:40	14.2	14.10	6.20	1.40
8/18/95 16:30	24.0	9.10	7.60	1.30
8/18/95 21:00	28.5	7.00	8.50	1.10
8/19/95 1:10	32.7	6.40	8.70	1.10
8/19/95 12:45	44.3	6.20	9.50	0.80
8/20/95 13:15	68.8	6.00	10.20	0.70



O_2 Utilization Rate

Ko	0.005 %/min
	0.273 %/hr
	6.558 %/day

Regression Lines	O_2	CO_2
Slope	-0.2733	0.1706
Intercept	19.1899	1.5012
Determination Coef.	0.8002	0.8224
No. of Data Points.	11	11